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ENGINEERING AND MINING JOURNAL

JULY, 1940

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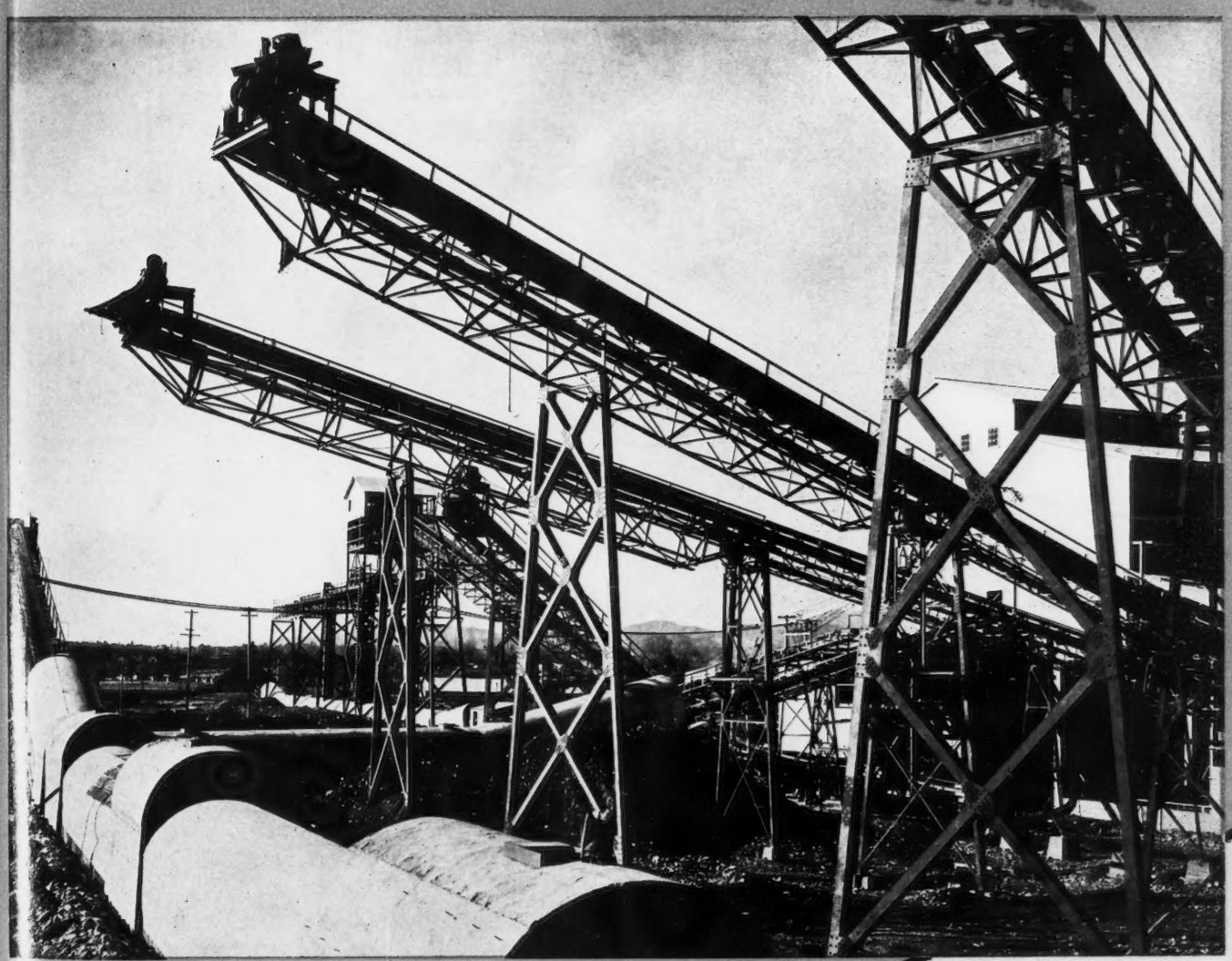

Gravel taken from Sacramento River bed to furnish sand and aggregate for Shasta Dam is first washed for gold at this plant near Redding, Calif. A 9½-mile conveyor line links plant and dam

In this issue

Differential Density Separation at Mascot
Placer Mining for Shasta Dam • Strategic Buying
More Light on Barodynamics • Safety at Climax
Economic Aspects of Philippine Manganese
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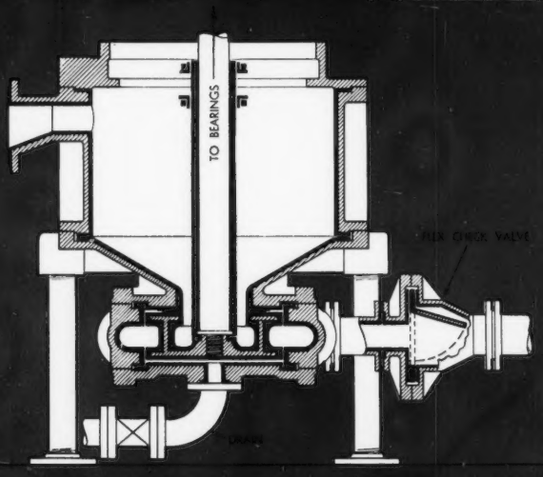

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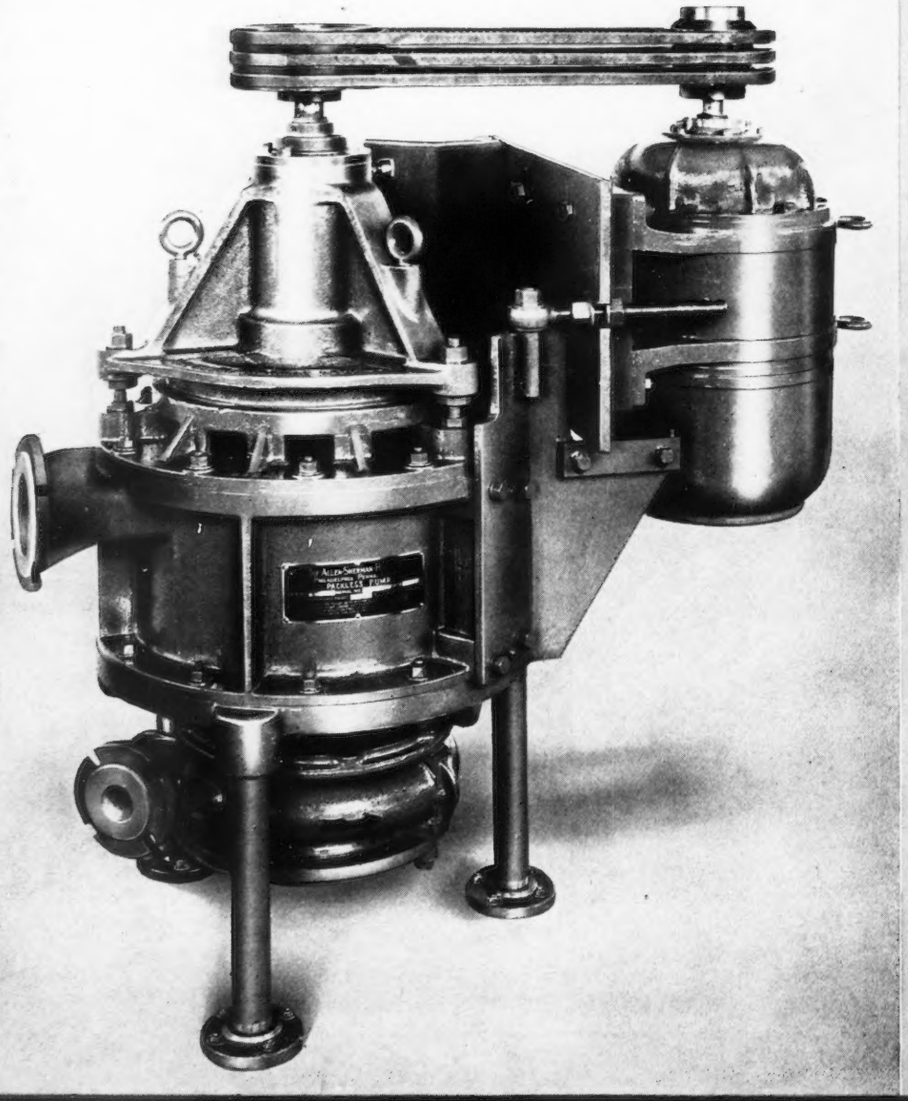

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Next month the "Small Mine Number" of *E. & M. J.*, special August issue, dealing with the smaller mining enterprises throughout the country. Of these there are hundreds for every one of large proportions that so often claim the limelight. Topics treated will include: the operation of small mines (by Charles F. Jackson); the design and construction of small mills (by E. L. Sweeney); small-scale smelting (by C. A. Weekley and S. W. Norton); bookkeeping for the small mining venture (by M. E. Peloubet); the small mine operators' movement (by A. L. Flagg); and various others, together with descriptions of certain companies' operations that fall within the issue's scope.

▼

Light reading, suitable for hot weather, features the last batch of literature received from the Bureau of Mines at Washington. Paul Tyler writes on "More Jobs for Minerals," in I. C. 7118, an erudite, intriguing paper that starts with the dawn of civilization and quickly comes down to the present, whether this present be sunset or high-noon—an excellent contribution dealing with such things as new metals graduating from the laboratory and finding work. It is worthy of wider circulation. S. J. Broderick tells about darkening light-color soils with coal-mine waste, in R. I. 3516. A valuable paper this, especially for those with coal mines and heaps of waste as well as for the farmers. Dark soil stays warmer, crops mature faster, cotton leaps ahead a month, and gladioli speed up. More will be heard of this in the future.

▼

Muscoda No. 5, underground limestone mine of Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., has won the "Sentinels of Safety" trophy in the non-metallic group of mines in the United States for 1939. The award was based on a record of 167,712 man-hours without a disabling injury. The same mine won the trophy in 1936 and 1937 also.

H. C. PARMELEE
Editorial Director

ENGINEERING AND MINING JOURNAL

H. W. CLARKE
Vice-President

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COVER ILLUSTRATION: Gravel taken from Sacramento River bed to furnish sand and aggregate for Shasta Dam is first washed for gold at this plant near Redding, Calif. A 9½-mile conveyor line links plant and dam. Photo by courtesy of U. S. Reclamation Service.

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Volume 141 JULY 1940 Number 7

Wanted—Industry Cooperation

LOOKING AHEAD to the cessation of hostilities in Europe, one cannot help speculating on the effect of that event on those industries in the United States that are supplying war materials to the Allies. Judging by past experience, contracts will be cancelled, production will cease abruptly, unemployment will rise, prices will fall, and business will collapse temporarily. Then will follow a long, painful process of rehabilitation that will be slow enough in spite of the demand created by our own preparedness program.

Much of the distress of that period could be avoided if industries were allowed to cooperate in their production and distribution programs without fear of violating the anti-trust laws. A pattern for such an arrangement exists in the Capper-Volstead law that makes it legitimate for agriculturists to cooperate in the production and sale of farm products, assuming protection of the public interest.

For the mining industry the point was brought out clearly by Mr. Kelley, then president and now chairman of the board of Anaconda Copper Mining Company, in his testimony before the T.N.E.C. last January. At that time he advocated measures to stabilize the copper industry—production, distribution, employment, price—by making it possible for producers to confer on such matters without facing criminal prosecution and jail sentence. He would welcome a representative of the Government at such conferences, and file the minutes with a governmental agency that would hold them open to inspection by the press and the public. If the representative of the Government felt that the conference was acting against the public interest, a complaint could be entered, an investigation held, and a cease and desist order issued if warranted. Failure of the industry to observe the latter might then entail prosecution. But up to that point the members of the industry would undertake self-regulation with the prospect, in Mr. Kelley's judgment, of more constructive action in the public interest than can be achieved under the narrow restrictions of a statute passed fifty years ago.

Mr. Kelley's proposal was the subject of a lively colloquy in which the chairman and several members of the committee joined. Chairman O'Mahoney stated that a proposal closely akin to that of Mr. Kelley had been made by Assistant Attorney General Thurman Arnold; and Senator King reminded the committee of an earlier proposal to empower the Federal Trade Commission to aid industry in self-regulation.

Cessation of hostilities in Europe will not be the only occasion on which it would be desirable to have self-regulation of industry to insure greater stability in production, distribution, and employment; but it is likely to furnish the next fine example of that need. As a measure of national defense Congress should consider legislation enabling industry to police itself as long as it shows due regard for the interest of the consuming public.

Manganese and Phosphorus

EXTRAVAGANT STATEMENTS, at times nonsensical, regarding the domestic manganese resources of the United States and their potentialities, have in the past decade helped to keep them from receiving the degree of serious attention they might otherwise have won. Extravagance draws ridicule, which is difficult to combat. Thus the subject of domestic manganese has been easily dismissed despite the long-recognized importance of the metal and the very large but uncommercial reserves of it that exist within our borders.

As it is, there has been some research, limited in amount but decidedly worth while. This has shown how high-grade manganese metal—almost the maximum possible concentration—may be produced by the electrolysis of sulphate solutions. Such high-grade metal may be bought today at a price which, though relatively high, could be lowered as production volume were built up.

Here comes to mind the successful and fascinating work that has been done in recent years with phosphate rock to render the contained phosphorus available to industry and agriculture, in forms and concentrations ranging up to

elemental phosphorus which is now produced and shipped by tank-car loads. This work is still in progress. What has been done with phosphate rock in the last twenty years might conceivably have been done with manganese ore, had the latter received the same attention. We hazard the guess that the steel industry could have learned to convert the elemental manganese into the forms in which it normally uses the metal, if not to use the maximum concentration, that is, the pure metal, directly. Perhaps under the stress of new fears of war, and the program of national defense, this change may be accelerated. One thing is certain—it can come about only with the cooperation of the steel men.

Production of domestic ores continues to be of small proportions, the current rate being in the neighborhood of 42,000 tons per year—a trivial amount. In the past, the would-be producer has all too often shown an inability to maintain promised shipments with respect to tonnage, or grade, or both. In general, these domestic ores require beneficiation, but the technical skill and requisite plant appear to have been lacking. Proposal is now made to build central beneficiation plants in certain areas having minable reserves. With the judicious rather than political selection of the sites, and provision of technically trained supervisors, such a plan should be productive of important new tonnage of beneficiated ore. But let there be an end of oratory. What is wanted now is tons, not words!

Lessee an Employee

IS A LESSEE of mineral ground, colloquially known in western mining districts as a leaser, an employee of the mining company that owns the property? The Supreme Court of Utah recently ruled in the affirmative in Hartle vs. National Tunnel and Mines Company, and thereby threw the leasing business of Utah into turmoil and confusion. Indeed, discontinuance of leasing operations throughout the State seemed imminent as the United States Smelting, Refining and Mining Company announced that leases expiring June 30 would not be renewed.

The court's opinion raises some puzzling questions. If the lessee is an employee, he is eligible for unemployment compensation. Is he entitled also to the protection of workmen's compensation for injury or death? If several lessees work in the same mine, are they privileged to organize like employees and claim the benefits of the Wagner labor relations act? May they strike for better terms, and bargain collectively with their leaser-employer? And do the terms of the wage-hour act govern their employment?

Offhand it is hard for a layman to reconcile the relationship of lessee and leaser with that of employee and employer. Probably it lies in some intricate legal interpretation that will still have to be reviewed by a higher court. Meantime the decision throws a cloud of doubt and uncertainty over a traditional form of agreement under which a substantial tonnage of ore is produced. If the opinion is ultimately sustained, some bright lawyer will have to devise a new form of contract that will permit the useful leasing system to be carried on.

Something to Defend

IF HITLER IS ABLE finally to dictate the terms of peace in Europe the whole world will come under the shadow of a new economic order. The Americas, and the United States in particular, will be squarely up against the problem of resisting not only military aggression, but also economic pressure that may profoundly alter the American way of life.

Disregarding for the moment the possibility of armed invasion of the United States, the economic consequences of a German-dictated peace in Europe are not lightly to be dismissed. Already the German boast is made that our huge gold reserve will be useless in international trade; that systems of barter will be introduced, reinforced by military might; and that the free economy of a democracy will be helpless to compete with the controlled economy of a totalitarian State.

Come what may, the outlook for American security warrants the swift preparations for military and economic defense now going forward at Washington. In a world dominated by men of ill will who rely upon force and chicanery to gain their ends, it behooves a peaceful nation to arm itself to the limit, and learn to combat the treacherous plots and schemes of an unscrupulous enemy. We have no alternative. Nor can we confine our plans to preparedness at home; they must contemplate the coordinated defense of a hemisphere.

The prospect is not a happy one. It means an uneconomic diversion of human energies from peaceful pursuits, a wasteful use of material resources, and an appalling tax on productivity, from all of which we shall not recover for a generation. But even more, it means achieving our security in the American way without losing our freedom; meeting the challenge of dictators without adopting their methods; and proving the capacity of free men for cooperation and solidarity under democratic institutions. It will be a long and costly process of defense, but infinitely preferable to supine acceptance of a ruthless dictator's peace.

Strategic Buying Planned

Complete coordination of Government effort arranged with speed to insure factual basis for mineral purchasing

Russell S. McBride
Consulting Engineer
Washington, D. C.

GOVERNMENT ACTION on strategic mineral problems was so rapid during the first half of June that a real program began to take form before the 20th of the month. As this summary is written, the plans are still changing. But the major framework of the organization, the objectives, and policies are sufficiently clear to justify a cautious interpretation.

Coordination of all efforts is the keynote and this coordination is sincere and effective. The magnitude of the program and the speed required are compelling all but a few to give enthusiastic support in whatever lines their efforts may be directed by the executive heads.

The secret of effective work lies in two facts: First, ample authority has been given to Dr. C. K. Leith, as executive of the program. Second, existing Government agencies having experienced technical men are being used to do the work. Acceptance of Leith has been enthusiastic. And the actions of the standard, old-line agencies of the Government have been anything but formal or ritualistic. Needless red tape is simply ignored. The right plan is made quickly and then is put into force at once by the best available agency, irrespective of who normally would be in charge.

As indicated in *E.&M.J.* last month the funds available for procurement of strategic materials are expanded beyond the wildest dreams of the advocates of the stockpile policy. As a consequence, methods formerly impossible because of limited funds are now feasible, and will be used. Real stockpile building is aggressively under way. Some bottlenecks that were thought to lie so far in the future as to be of no consequence are now brought into the foreground and are getting attention.

There is no single pattern to be followed for the various mineral projects. Each commodity requires its own distinctive handling, and will receive separate consideration. There will be, of course, a broad general framework on which each program will be organized. But results obtainable, not methods used, are the determining factor.

Of outstanding importance are the problems of securing adequate supplies of tin, chromium and manganese. Of very different magnitude as to dollar and tonnage are the problems of sheet mica, piezo-electric quartz crystal, tungsten, long-fiber asbestos, and graphite, to name a few. Of the distinctive problems there are many, such as that of nickel. In fact, the dissimilarity of the problems confronted in the case of related metals and minerals has made it necessary that all of the programs be regarded as wholly technical.

Programs being formulated are requiring first a complete resurvey of needs and resources. Estimates made for the Army and Navy Munitions Board less than two years ago are sadly out of date. One simple example will show why this is true, the problem of sheet mica.

Suppose one were required to plan for 10,000 airplanes. It would be comparatively easy to figure the amount of so-called "cigarette mica" required for the high-temperature spark plugs of these aircraft. But now one must consider the possibility of 50,000 planes per year, or possibly even 100,000 planes when both domestic and British requirements are analyzed. Supplies of mica formerly thought fair, if not satisfactory, become pitifully inadequate. And it is doubtful whether there is an adequate world supply of this mineral which can be made available to American builders of engines and spark plugs within a reasonable length of time, irrespective of cost or transportation difficulties.

No one doubts that, short of a successful bombing of the plants at Sudbury, sufficient nickel will be mined in Canada to supply both British and American needs. But even such a commodity is requiring new appraisal of demands so as to insure that supplies may be allocated without leaving out some important, though minor, use. And the question of price is not being ignored, because it is ridiculous to allow agencies that should be cooperating to compete for a single supply.

Two other examples of expanded demand for minerals deserve attention. These are in the cases of tungsten and chromium. The Navy formerly considered itself busy when it was building a dozen or so important ships at one time. Now Congress thinks nothing of adding 20, 50 or 100 vessels to the authorized fleet in a single day, with negligible debate. The increase in demand for armor plate is obvious, likewise the corresponding demand for alloying elements with which to make it.

Much has been heard about the shortage of experienced machinists, die makers, and machine-tool workers. The shortage of tools has been shouted from the house tops. But few save Government specialists in strategic commodities have realized what this means with respect to tungsten, for example. This is one of the elements in which the United States is now

Strategic Materials

Revised List

The Army and Navy Munitions Board prepared the following revised list of strategic and critical materials early in 1940:

Strategic Materials. Antimony, chromium, cocoanut shell char, manganese, ferro-grade; manila fiber, mica, nickel, quartz crystal, quicksilver, quinine, rubber, silk, tin, tungsten.

Critical Materials. Aluminum, asbestos, cork, graphite, hides, iodine, kapok, opium, optical glass, phenol and pieric acid; platinum, tanning materials, toluol, vanadium, wool.

In preparing these lists, three commodities—aluminum, optical glass, and wool—were removed from strategic to critical classification. Also, there were eight commodities moved from critical to essential status, namely, cadmium, coffee, cryolite, flaxseed, fluorspar, nux vomica, scientific glass, and titanium. However, the Board no longer gives quite the same attention to the so-called "essential" commodities, and it may be that such a third list will cease to be significant.

The earlier estimate of the quantities of the strategic materials, manganese, chromium, tungsten and tin, required by the Army and Navy Munitions Board were published in *E. & M. J.*, January, 1938, p. 80. The earlier list of preparedness materials as defined on Jan. 7, 1939, appeared in the February, 1939, issue of *E. & M. J.*, p. 105.

practically self-sufficient so far as the peace-time demand is concerned. But within a few weeks or months at the most, the problem of supply will be greatly increased. When one multiplies the demand by 4 or 6, or by whatever the factor should be, the new difficulties become obvious. This type of bottleneck has been vaguely understood for some time. But it has never been in the spotlight in Washington, even among the mineral specialists, until the developments in mechanized warfare made obsolete all previous planning.

Obviously, the most important bottleneck in much of the planning is that of transportation. How can one bring Turkish chrome ore out of the eastern Mediterranean under present circumstances? No one pretends to have the answer. Alternative transport efforts must be studied. Chromite, though now the most conspicuous, is by no means the only commodity which could be had from reasonably friendly sources *if* the sea lines are kept open.

Strangely enough, price considerations have thus far proved to be a very minor obstacle. This to certain officials is most encouraging. It means that the Government is getting unselfish cooperation.

Necessarily Washington is making certain assumptions as to which ports of the world will remain accessible to the United States. At no time does any one assume that the United States will have any serious difficulty in protecting the sea lanes to Cuba and Brazil. This being true two of the world's sources of manganese will continue accessible to our ships. Bauxite from Guiana also is presumed to be available without interruption of supply. There is grave question, however, whether African sources of manganese and chromium will be equally accessible at all times.

There is much speculation, but no clear thinking, in mid-June as to what may happen if actual or claimed control of the colonial empires passes into unfriendly hands. No one likes to talk about what Nazi control of Dutch resources might mean. This is being written just as the French military organization has collapsed. Washington now rightly refuses even to speculate what the German terms may be or what they may mean to our relations with the Far East or with some British territorial areas.

The enthusiasm of some would-be helpful groups is proving embarrassing to Washington officials at the moment. These executives are worried lest mining engineers and corporation executives believe that red tape is holding up the program. At the outset it has been necessary to tell many who offer help that there is really no aid which can be accepted at the moment. This means that, as these Government officials say, Washington does not yet quite know what it can ask outsiders to do. The cooperation asked must be planned to fit into the great national picture of mineral supply, to insure fairness to both Government and outsiders as well as for effectiveness.

Literally hundreds of projects have been brought to the Defense Commission, Bureau of Mines, and Geological Survey. Among them are, doubtless, important and useful proposals, which will have to be sifted out.

And there are offers of quite another kind. These are the proposals, far from unselfish, which come usually through political channels. They form the most serious threat to real progress. Fortunately, they are few in number.

Varied Plans

As said before, no one expects that any single program will suffice for any one of the major tasks of mineral supply. Respecting manganese, the following possibilities are under investigation:

1. Every ton that can safely be brought to the United States will be purchased, whatever its source.

2. Contribution to the stockpile from domestic sources will be encouraged by prompt purchasing so long as the price is not excessive. But anything savoring of a new "War Minerals Relief" effort will be strongly opposed, as wasteful and unwarranted.

3. The Reconstruction Finance Corporation has abundant money to loan to industrial groups that can get supplies abroad.

4. Reduction in American demand by substitution will be encouraged.

5. Encouragement, possibly financial subsidy, will be given in some cases to those with worthwhile schemes for converting low-grade domestic manganese materials into satisfactory substitutes for high-grade imported ore.

6. Research on electrometallurgical technics may be accelerated.

7. Quotas and priorities will be recalculated.

8. Continuing critical and intimate supervision will be given so that at any moment the Government executives may know as to stocks, reserves, capacities, prospective imports, all bearing on supply, and the corresponding demands ranging from the imperative to the postponable.

The President has ample authority to support any program which may seem necessary under the semi-war conditions. With respect to raw materials he has given this authority to Mr. Stettinius, his deputy. As the latter's aid, Dr. Leith has a very satisfactory basis for procedure. There is neither intention nor need of cracking of whips over possibly recalcitrant units of government or industry. But no doubt exists that under his present powers, the President can take any necessary steps to secure needed action.

Priorities in disbursements of strategic materials may ultimately be required. A priority list of uses and users is undoubtedly going to be formulated soon for each commodity. But it is not expected that anything approaching the 1917-1918 regulatory priorities will become necessary in the immediate future.

Apparently the President has let it be known that he regards Mr. Stettinius' organization as superior to all of the other career groups of the government. That is fortunate. It restrains any disposition on the part of some official to have an unwarranted pride in the responsibilities or prerogatives of his old-line agency. It also makes clear how otherwise uncoordinated groups may function together under a common superior.

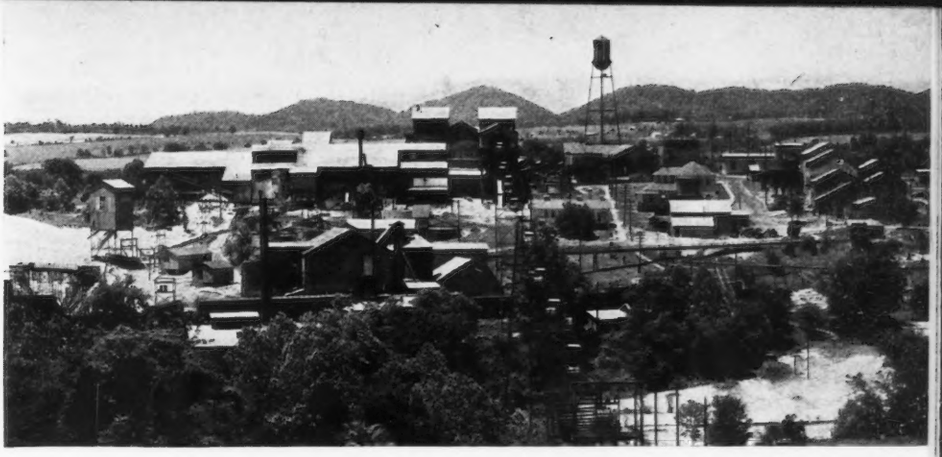
Congress is making appropriations on a huge scale these days. Directly or indirectly there are available for strategic mineral activities monies approximating a billion dollars. But the funds available are not the important consideration just now. The question is, "What can the Government get?" Problems are being formulated "to get all that we can at any decent price." So far as minerals are concerned, the availability of an essential material makes its cost a secondary matter.

For immediate stockpile purchasing, facilities of the Procurement Division of the Treasury Department will be utilized to the full. That agency, ably managed by Captain Collins, has built up a reputation for speed and direct action. It has the stimulus of a new director, Donald M. Nelson, an experienced engineer formerly executive vice-president of Sears, Roebuck & Co. With the advice of Dr. Leith it will continue the purchasing of wanted mineral commodities.

Huge additional sums are available for loans, generally through the R.F.C., whose mining division is actively cooperating with the rest of the strategics unit. A number of big industrial units will, it is hoped, do their own purchasing of mineral raw materials, such as the strategic ferroalloy ores. R.F.C. is prepared to make loans to such concerns to encourage that action as a supplement to direct buying by the Government.

The whole program of procurement is being coordinated. There is to be no bidding of companies against Government or of one Government agency against another. Any man who wants to buy something for a part of this program will be helped to do so in such fashion as to preclude needless conflict of interest. It is too much to hope that no one will be disappointed or that no sharp shifts in prices occur. But the program is being so managed as to minimize the opportunity for such unfortunate results.

By the Metallurgical Staff
American Zinc, Lead and Smelting Co., Mascot, Tenn., and St. Louis, Mo.



The concentrator of the American Zinc Company of Tennessee at Mascot, in the background

Differential Density Separation at Mascot, Tennessee

American Zinc's sink-and-float process gives notable results, eliminating 52 to 63 per cent of total tonnage after crushing through 1 1-2 in.

Recent operations show 93.27 per cent over-all recovery on 2.89 per cent heads, with total tails of 0.225 per cent and D. D. tails of 0.33 per cent. Ore treated thus far exceeds 1,000,000 tons

THE differential density process now in operation at the Mascot, Tenn., property of the American Zinc, Lead & Smelting Company is the result of extensive research work in the development of the sink-and-float method of mineral beneficiation. Successful treatment at this concentrator of over 1,000,000 tons of zinc ore has removed the process from the experimental stage and established it as a major development in concentrating practice.

As developed at Mascot, the process, known as the M.B.I. differential density process, consists of the continuous rejection of a large proportion of the mill feed as a barren tailing by passing coarsely ground ore through a cone filled with separating medium of high specific gravity. The Mascot medium is a suspension of galena in water in which the barren gangue floats and the ore sinks.

The basic principles for the sink-and-float method are the same as for concentration by jigging or tabling. Preliminary tests were therefore necessary to determine the limits of grain size for optimum results. The presence of fine granular or colloidal particles of material having a lower specific gravity than that of the suspended solid of the medium has three decided disadvantages. First, they lower the specific gravity of the medium because of their own lower specific gravity; second, they lower the specific gravity of the medium or require the addition of make-up solids by introducing excess water through entrainment or occlusion; and third, they alter the physical characteristics of the medium, particularly its viscosity and consequent separating power.

The mechanics of the separation are simple. The prepared feed is delivered continuously to a cone filled with the heavy density medium. The lighter tailings float and overflow a weir discharge with a large amount of separating medium. This medium is drained through a vibrating screen and returned to the cone. The drained oversize is washed free of adhering medium on a second vibrating screen. The mineralized particles sink to the bottom of the cone, are elevated with a portion of the heavy density medium by a central air lift, and are drained and washed on two screens similarly to the treatment of the tailings.

In 1935 the first test unit was built. The separatory cone was 3 ft. in diameter. Shaker-type screens provided for drainage of the medium from both concentrates and tailings and for the necessary washing. The medium of galena and water was stored in a cone.

The Mascot ore is a lead-free sphalerite, more or less disseminated in a dolomitic gangue rock and accompanied by a small amount of flint and recrystalline rock. A mineralogical analysis is given in Table I.

About fifty tests were made on ore of varying screen size in amounts ranging from 900 to 23,000 lb. The results indicated that with the existing milling equipment a feed coarser than $\frac{1}{8}$ in. should be used in the treatment of the Mascot ore, the upper limit being dictated by operating considerations of the crushing plant, disposal of sized tailing for sale, etc. With this determined, twelve tests were made using a feed sized between minus $1\frac{1}{4}$ in. and plus $\frac{1}{8}$ in. to determine the capacity of the separatory cone.

The data of two representative tests are given in Table III, page 37.

With the test plant experience as a basis, the next step in the development of the process was the construction of a unit with a separatory cone of 6 ft. diameter and the necessary auxiliary equipment. This unit, designed to han-

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The Differential Density cone process being used by the American Zinc Company of Tennessee at its Mascot, Tennessee, operations, and by the Eagle-Picher Mining & Smelting Company at its Central mill operations in the Picher, Okla., district is now treating at the rate of approximately 3,500,000 to 4,000,000 tons zinc ore annually. The entire tonnage of both properties is being handled by this process. The American Zinc, Lead & Smelting Company, 943 Paul Brown Building, St. Louis, Missouri, exclusively controls the licensing of this process in the United States, Mexico, and Canada for all types of ore and coal.

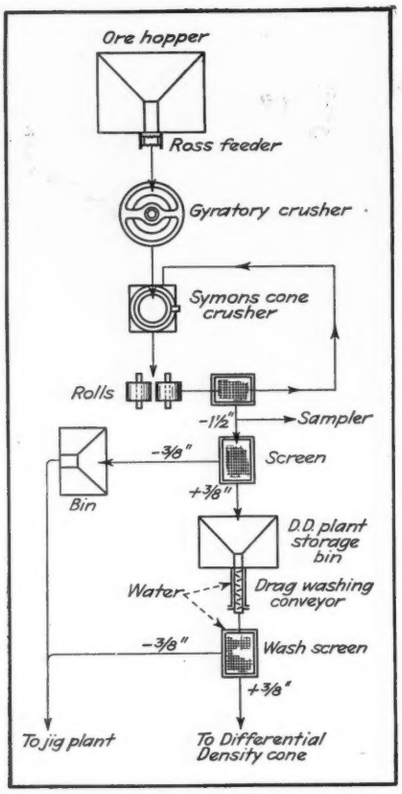


Fig. 1 . . . Steps in ore preparation ahead of the jigs and the differential density cone in the Mascot flowsheet

dle five tons per hour, ultimately treated 75 tons per hour and became a part of the mill circuit. In 1938, after eighteen months of operation, it was replaced by a cone of 9 ft. diameter which, since February, 1939, has become the major step in gravity concentration and has replaced all jigs for coarse ore treatment.

Use of the 6-ft. cone gave the necessary experience with such operating details as feed preparation, maintenance of the medium, washing of the products, water, power, and reagent consumption, but the data obtained are not of particular interest for this paper. They showed the process to be simple and economical and that a decided increase in milling capacity could be attained with a relatively small capital outlay.

To what degree this was possible is shown in the following paragraphs. Table II gives a comparison of some mill data before and after the introduction of the M.B.I. process into the flowsheet.

The screen analysis given in Table IV shows the size of the rejected tailing and the distribution of zinc in these sizes. The high zinc assay of the minus ¼-in. portion is due to attrition of sphalerite but represents only 0.7 per cent of the total weight and 3.8 per cent of the zinc in the tailings.

A graphic flowsheet of the ore preparation is shown in Fig. I. The run of mine ore is fed from the hopper by a Ross chain feeder onto a 48-in. belt conveyor which delivers it to a 30-in. McCulley gyratory crusher. The product is conveyed by a 24-in. belt conveyor to a No. 4 Symons cone crusher in closed circuit with an Allis-Chalmers low-head-type screen with 1.5-in. square openings. Formerly a set of 20x54-in. rolls was in the circuit, but at present the ore passes through them without grinding and after being sampled is conveyed to two low-head-type Allis-Chalmers screens, equipped with ⅜-in. round-hole punched-plate screens. A chain bolted to the plate has been found useful in preventing blinding when the feed is wet. (Fig. 2.)

The oversize from these screens is conveyed to the feed storage bin for the differential density unit. The ore from this storage bin is washed in a drag conveyor. From the drag conveyor it passes to two shaking screens for final washing. The spray water used is applied through fish-tail sprays suitably placed. To insure the greatest washing effect, strips of old conveyor belting are bolted to the screen at right angles to the ore flow, causing the rock to tumble and present all sides to the water sprays. (Fig. 3.)

The undersize from these washing screens is deslimed in a small drag classifier, the sands going to the fine grinding circuit. The slimes join the slime overflow from the drag conveyor in a Dorr thickener whose underflow goes to flotation. The overflow is returned to the washing conveyor making a closed circuit for the wash water. The washed oversize is fed to the separatory cone of the differential density unit by a 20-in conveyor belt seen at the right in Fig. 4. The slope of this belt is rather steep to allow the feed to drain thoroughly before entering the cone. Moisture content of the feed is approximately 1.7 per cent. Low moisture content in the cone feed is desirable to prevent dilution of the top medium in the cone.

The separatory cone is 9 ft. in diameter and 8 ft. 9¾ in. from the bottom plate to the weir overflow. It

Table I. Mineralogical Analysis, Mascot Ore

	%
Calcium carbonate	48.11
Magnesium carbonate	35.36
Silica	8.73
Alumina	1.04
Iron as oxide	1.33
Zinc sulphide	5.43
Total	100.00

Table II. A Comparison of Mill Data Before and After the Introduction of the M. B. I. Process

	Years 1931–1935	March-Dec. 1939
Mill feed		
Size	(*a*)	(*b*)
Tons per 24 hours.	1,898	2,703
Assay, % zinc.....	2.78	3.12
Concentrates		
Jig		
Tons per 24 hours.	25	47
Assay, % zinc.....	58.86	58.38
Total zinc, %.....	28.15	32.50
Flotation		
Tons per 24 hours.	52	81
Assay, % zinc.....	61.14	62.65
Total zinc, %.....	59.68	60.11
Tailings		
Coarse		
Tons per 24 hours.	859	1,542
Assay, % zinc.....	0.66	0.33
Total zinc, %.....	10.69	6.08
Flotation		
Tons per 24 hours.	962	1,033
Assay, % zinc.....	0.081	0.107
Total zinc, %.....	1.48	1.131
Total mill recovery, %..	87.83	92.61
Ratio of concentration..	24.65	21.20
Power consumption		
Kw. hr. per ton feed..	13.38	11.33

(*a*) Minus 5/8-in. round hole.
(*b*) Minus 1½-in. square hole.

Fig. 2 . . . Oversize from these two low-head-type screens, having ⅜-in. round-hole punched-plate screen, goes to the feed-storage bin for the differential density unit

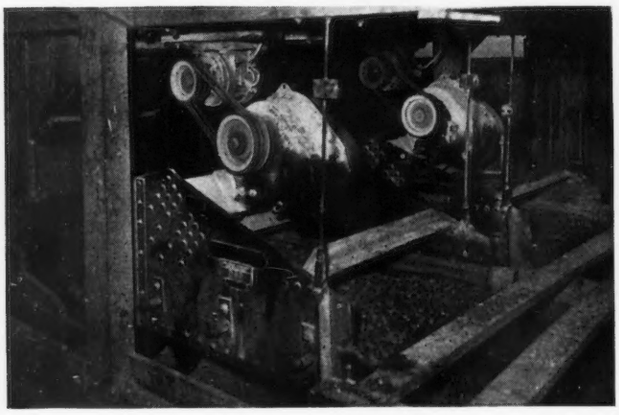
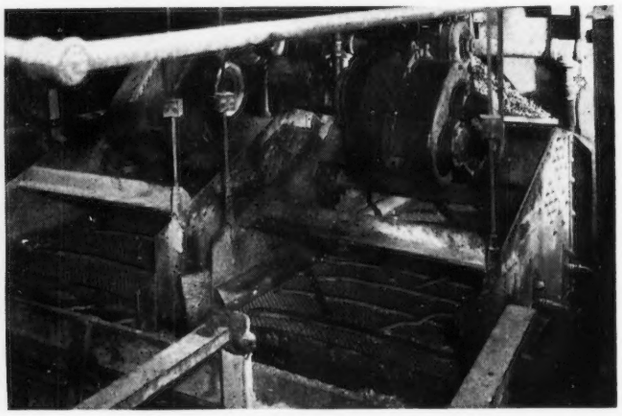


Fig. 3 . . . These two shaking screens give a final washing to the feed from the differential density storage bin before it goes to the separatory cone



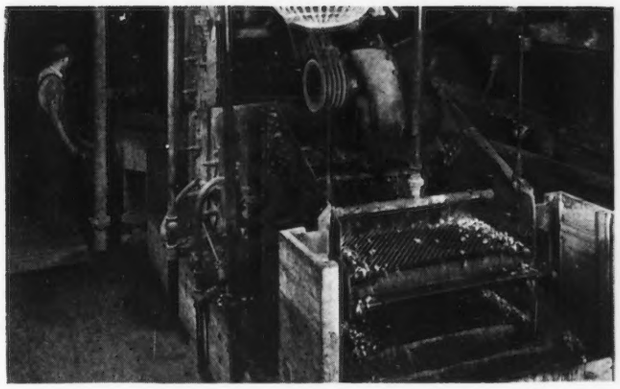


Fig. 4 . . . In the rear is the separatory cone of the differential density unit. At the right is the 20-in. conveyor leading to it

Fig. 5 . . . The weir overflow of the separatory cone delivering to the tailings drainage screen may be seen at the extreme right

is made of ½-in. steel plate with welded butt joints to give a smooth inside surface and is stiffened at the top with a 6x4x½-in. angle iron which also forms the lip of the weir overflow. A ring of ¼-in. plate 6 in. high is welded to this angle iron. The bottom of the cone is 15 in. in diameter and is stiffened by a ring of 1-in. plate. The bottom plate is bolted to this ring and contains a pipe nipple 9 in. long for the introduction of air for the air lift. Two shorter nipples are also provided for air agitation in case of a stop-up. A 4-in. gate valve is provided for emergency drainage.

A 6-in. diameter pipe extends upward from the bottom of the cone and through this the concentrates are elevated and discharged. At present this air lift has a submergence of 80 per cent, permitting the use of a very small amount of air and obviating the circulation of an excessive amount of medium. A 12-in. pipe is concentric with the air lift and extends to the height of the cone. This exterior pipe allows the medium drained from the screens to be returned to any depth in the cone. Under the method of operation now used at Mascot all the returned medium as well as the make-up medium is added to the surface of the heavy density mass in the cone. Two triangular-shaped stirring arms are attached to this pipe and the entire assembly is driven at a speed of 4½ r.p.m. by an electric drive mounted on the cone.

The slowly rotating paddles serve two purposes. They prevent the formation of galena masses on the side of the cone and aid in distributing the feed over the cone surface by rotating the liquid mass at a slow speed but maintaining a quiescent surface.

The weir overflow is 3 ft. 8 in. wide, the material falling onto an apron welded to the side of the cone and flowing onto the tailings drainage screen. It will be seen at the extreme right of Fig. 5.

Circulation of galena medium over the weir and up the central (concentrate) air lift amounts to approximately 175 g.p.m., of which the tailings drainage accounts for 80 per cent.

The air lift discharges the concentrates and medium to an Allis-Chalmers low-head vibrating screen where the greater part of the adhering medium drains off and returns to the cone. The concentrates are then washed on a second screen and are conveyed to the jigging plant for further treatment. The drainage from the Allis-Chalmers screen receiving the weir overflow is collected in a cone also equipped with an air lift. The medium is thickened in this cone, the air lift returning it to the separatory cone, the overflow being pumped to a 20-ft. Dorr thickener.

The tailings are given an intensive washing similar to that for the feed material on Allis-Chalmers screens of the same type. The wash water is combined with that from the concentrates and the overflow from the cone thickener and goes to the Dorr thickener previously mentioned. This thickener serves a double purpose: for rejection of fine ore and slime from the medium and as a storage for the medium. All new galena is added to the thickener. The spigot is pumped to the separatory cone by a Dorr suction pump.

Thus the description of the equipment of the separating process. The equipment for cleaning the medium will be described later. The isometric drawing shown in Fig. 6 gives a flowsheet of the D. D. unit. Fig. 7 shows the separation.

The operation of the unit is extremely simple. The prepared feed drops continuously from the conveyor at (1) onto the surface of the fluid mass which has a slow rotary motion imparted to it by the paddles (4). The slow turning of the mass permits the even distribution of the feed over the tranquil surface of the heavy density medium and assists in the maintenance of the differential density in the cone. The tailings, which have a specific gravity of 2.80, overflow the weir onto drainage screen (8), pass to the washing screen (12) and leave the plant by

Table III. Typical Pilot Tests on Mascot Ore

Test No. 1C

Treated 13,095 lb. of —1 in. +3 Mesh Feed, Pounds Per Hour, 2,500

	Dry Solids			Zinc Contents		
	Lb.	% Cone Feed	% Mill Feed	Assay % Zn.	% Cone Feed	% Mill Feed
Concentrates	1,587	12.1	9.3	15.15	86.7	47.4
Tails	11,508	87.9	67.6	.32	13.3	7.2
Cone feed	13,095	100.0	76.9	2.11	100.0	54.6
Fines	3,734	....	23.1	6.15	....	45.4
Mill feed	17,829	....	100.0	2.97	....	100.0

Test No. 31

Treated 2,720 lb. of —1¼ in. +3 Mesh Feed, Pounds Per Hour, 2,640

	Dry Solids			Zinc Contents		
	Lb.	% Cone Feed	% Mill Feed	Assay % Zn.	% Cone Feed	% Mill Feed
Concentrates	295	10.8	8.0	13.92	85.4	46.6
Tails	2,425	89.2	66.1	.29	14.6	8.0
Cone feed	2,720	100.0	74.1	1.77	100.0	54.6
Fines	951	....	25.9	4.21	....	45.4
Mill feed	3,671	....	100.0	2.40	....	100.0

Table IV. Screen Analysis of Coarse Tailing

	Solids		Zinc			
Screen Size	% Weight	Cum. % Weight	Assay % Zn	Cum. Assay	% Total Zinc	Cum. % Total Zn
On 1¼-in. square hole	7.2	7.2	0.20	0.20	4.7	4.7
1⅛-in.	11.1	18.3	0.26	0.24	9.8	14.5
1-in.	15.1	33.4	0.25	0.24	12.4	26.9
¾-in.	27.1	60.5	0.28	0.26	25.4	52.3
⅝-in.	11.8	72.3	0.29	0.26	11.5	63.8
½-in.	11.6	83.9	0.35	0.28	13.7	77.5
⅜-in.	10.0	93.9	0.39	0.29	12.9	90.4
¼-in.	5.4	99.3	0.32	0.29	5.8	96.2
—¼-in.	0.7	100.0	1.67	0.30	3.8	100.0

conveyor (17). The concentrates which have a specific gravity of about 3.0 are discharged by the air lift to the drainage screen (5), are washed on screen (7) and leave the unit.

The entire separation depends upon the physical characteristics of the medium which at Mascot is a suspension of galena in water. The particle size is important to maintain fluidity. For Mascot ore, experience indicates that a medium of the screen analysis in Table V is most desirable.

The fluidity of the medium depends not only on the particle size but also on the absence of interfering colloids. Their presence makes the medium more viscous and decreases the sharpness of the separation and the tonnage that can be treated in unit time. It is necessary to secure their dispersion by a suitable agent, that used at Mascot being tri-sodium phosphate. It is used in an amount to keep the water in the system at a pH of 9.5.

Presence of material having a lower specific gravity than galena either decreases the specific gravity of the medium or, if the gravity is maintained at the requisite figure, increases its viscosity. To eliminate such solids requires a cleaning system which is operated continuously. Fig. 6 shows the method used at Mascot in 1939.

The function of this system is to maintain the medium at its optimum density by rejecting colloidal ore and galena particles and by rejecting diluting water which enters the circuit entrained in the ore and introduced by washing the medium from the products.

Table V. Screen Analysis of Galena in Separation Medium

Screen Size	% Weight
On 100 mesh	4.6
150 mesh	5.2
200 mesh	8.8
325 mesh	16.4
Through 325 mesh	65.0
Total	100.0

Table VI. Analysis of New Galena As Added to Medium Tank

	Weight, %	Cumulative, %
On 10 mesh	2.15	2.15
20 mesh	7.59	9.74
35 mesh	11.85	21.59
65 mesh	19.17	40.76
100 mesh	24.39	65.15
150 mesh	16.62	81.77
200 mesh	9.70	91.47
325 mesh	5.66	97.13
Through 325 mesh	2.87	100.00
	100.00	

The wash water from the screens (4) and (6) was combined with the overflow from the storage cone (7). It was pumped to a settling cone (8), whose overflow went to the Dorr thickener (11) and whose underflow was treated on a standard size Deister-Overstrom table for removal of the coarse galena, which, together with the slimes, was returned to the Dorr thickener. The non-metallics from this table were cleaned on a half-sized Wilfley table (10), the sands going to the clarification tank (13) and the overflow rejoining the metallics in the Dorr thickener (11). The underflow from this thickener is pumped continuously to the separatory cone to maintain the medium at its required density.

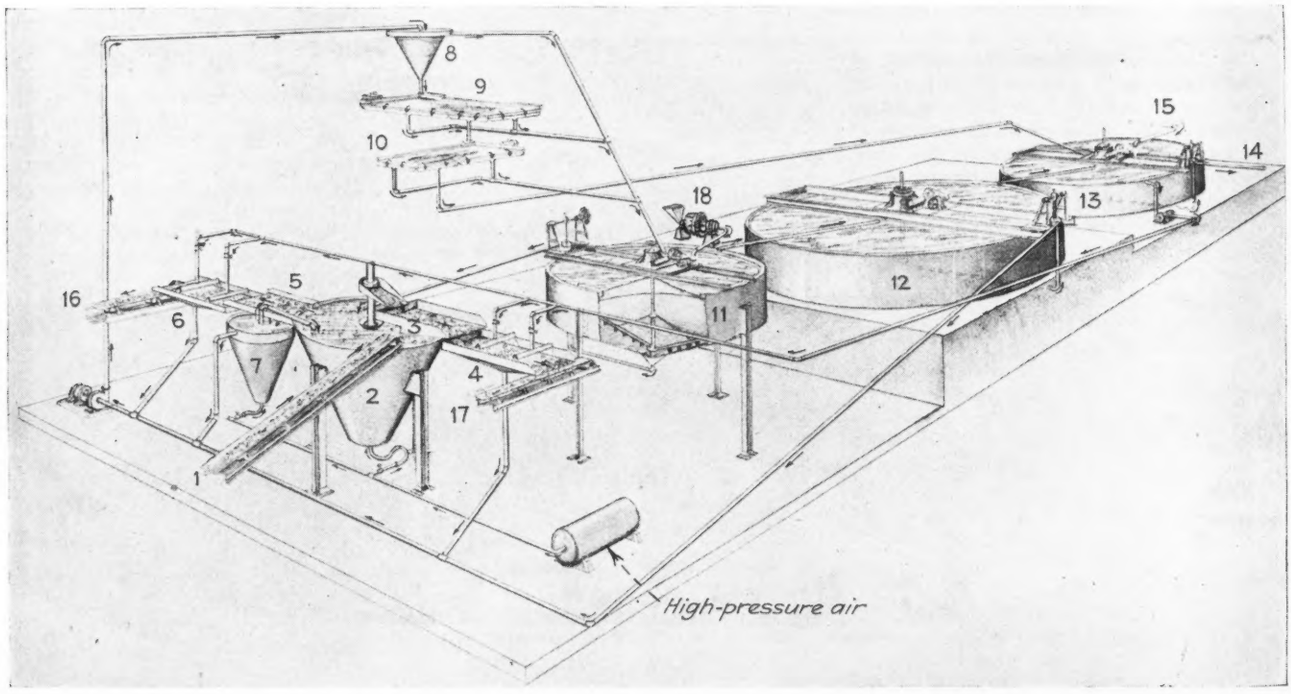
The new galena which is added to make up for the mechanical losses and the colloidal reject is fed to this thickener together with the underflow from the decantation tank (12).

The supply of new galena is added once per eight-hour shift. Galena jig concentrates are ground through a 3-mm. round-hole screen in a small ball mill as needed. The grinding is conducted so as to make a minimum amount of minus 100 mesh galena in the product. Table VI gives a representative screen analysis of the new galena as added to the medium tank.

The density of the medium in the separatory cone increases constantly downward. Part of this increase is due to settlement of the galena and a part due to the converging of the cone at its apex. The density at the top is maintained at 2.80 specific gravity and at the bottom at 2.95 specific gravity. It is believed that this differential eliminates particles whose gravity lies between the above limits, preventing their accumulation in the cone. An Adams density indicator registers the gravity at all times so that the operator may change the

Fig. 6 . . . Isometric drawing illustrating the flowsheet of the differential density, or D. D., unit. The text explains both this and Fig. 7

1. Sized washed feed
2. (D.D.) Differential density cone
3. Concentrate drainage screen
4. Concentrate wash screen
5. Tailing drainage screen
6. Tailing wash screen
7. Tailing drainage air lift
8. Settling cone
9. Coarse lead table
10. Sand removal table
11. Make-up medium
12. Decantation tank
13. Wash-water clarification tank
14. Sand and slimes discarded
15. Make-up water
16. Plant tailings
17. Plant concentrates
18. Galena make-up



addition of make-up medium to keep the cone density at the required figure. Hand sampling hourly keeps a check on the indicator. The Adams indicator can be connected with the medium supply to make the addition of new medium automatic.

Overflow from the Dorr thickener (11) goes to Dorr thickener (12) used to decant the water and the colloidal solids from usable galena. The overflow from this tank passes to the clarification tank (13) from which the clear overflow returns to the system for spray water. The thickened solids, containing about 32.5 per cent lead, are sold for their lead content. All make-up water is added to the system in the clarification tank.

The water demands for the differential density unit are slight. The water used for washing off entrained medium is recoverable as the galena carried off by it must be recovered. The only loss is water entrained in the products and floor spillage, both of which are nominal. Satisfactory washing of the products is obtained by the use of 43.5 gal. of water per ton of material washed. As the tonnage of concentrates to tailings at Mascot is in the ratio of 1 to 6, the greater part of this water is used on the tailings.

As will be seen in Table VII, the cost of medium is the greatest single item in the operating cost of the differential density process at Mascot. The installation for maintaining the medium in proper physical condition is also designed to recover as much galena as possible because of its cost. Such medium as adheres to the discarded tailings is lost. A special test to determine the magnitude of this loss showed the following.

Table VII. Direct Operating Costs, Mascot Unit

	Cents Per Ton Mill Feed
Labor	1.25
Power	0.8
New galena added	6.0
Repairs	1.0
Miscellaneous	2.0
Total	11.05
Credit for galena recovered from slimes	3.00
Net operating costs	8.05

Shift samples of the tailings were screened on a 65-mesh screen and the undersize was assayed for lead. The undersize was 0.09 per cent of the total weight and assayed 9.21 per cent lead. Calculating this to galena with a lead content of 80 per cent, a loss of 0.213 lb. of galena per ton of cone tailings or of 0.14 lb. per ton of mill feed is arrived at. The remainder of the galena loss can be attributed to spillage and rejection of colloidal galena with the colloidal gangue material. Over a two-year period galena recovered in the rejected slimes was sufficient to reduce the cost of new galena added by half.

Direct operating costs for the Mascot unit, based on experience to date, are itemized in Table VII.

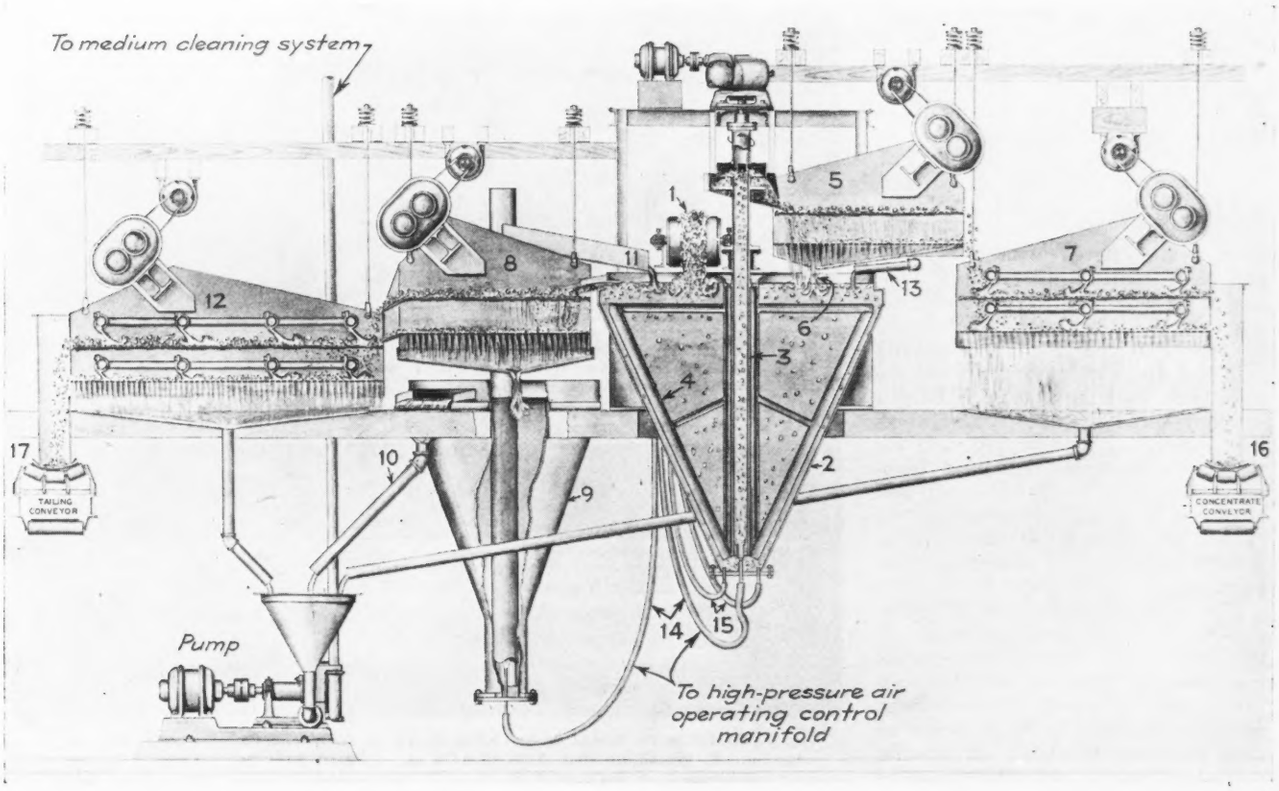
The labor cost is for three men per shift. A newly designed plant should require only two men. No charge for royalty, depreciation, or capital charge is included.

It will be noted that galena is the chief item of expense. The most recent figures from Mascot indicate that the consumption of galena will be decidedly lower than shown, but it seems advisable to use actual figures covering a longer period of time.

The economic advantages for the entire Mascot concentrator lie in the treatment of more ore than was possible with the mill equipment as it existed, the treatment of this ore with four less men than were necessary with the old flowsheet, an increase of over 4 per cent in the over-all zinc recovery, a decrease of 15 per cent in total power consumed per ton of mill feed, and the production of a larger tonnage of coarse tailing which is a salable and valuable byproduct.

Fig. 7 . . . The differential density separation with the steps immediately following are shown in this sectional drawing

1. Sized washed feed
2. (D.D.) Differential density cone
3. Concentrate air lift
4. Agitator rake
5. Concentrate drainage screen
6. Return medium, concentrate drainage
7. Concentrate wash screen
8. Tailing drainage screen
9. Tailing drainage air lift
10. Tailing drainage overflow
11. Return medium, tailing drainage
12. Tailing wash screen
13. Medium make-up
14. Air to air lifts
15. Air for auxiliary agitation
16. Washed drained concentrates
17. Washed drained tailings



A Practical Way of

Attacking Problems of Structure and Ground Support

More light on the recently developed procedure of barodynamics

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IN VIEW OF the numerous requests for a non-technical explanation of barodynamics that have been made by men who have been in the field for ten or twenty years or more and who say they have become rusty in their physics and mathematics, I have undertaken to write this article. The task is not easy, for physics is advancing rapidly and textbooks of physics of ten years ago are considered out of date, not because the information obtained then was incorrect but because new concepts have been introduced. These texts bring in new terms and explanations on the basis of calculus, with discouraging effects on old-timers. The result is that unless the student of ten years ago has spent some time in keeping up with the new concepts and procedures, he finds difficulty in understanding not only the subject but the young engineer who comes to work for him.

Barodynamics may probably best be explained by stating that its object is to provide a sound basis for solving the structural problems dealing with the underground workings, the surface, and the geological material in between. For example, what span shall the room or stope have? What dimensions and shape shall the pillars have? What timber dimensions, structure and spacing is most economical? What length of face shall be used in longwall? Will the ore block-cave and what development work is required? To this list may be added many others which the reader may now supply with the reasonable assurance that these problems may now be investigated and answered in a manner other than by cut-and-try methods in the field, or directly following the procedure of an operation in the vicinity.

For an understanding of the procedure involved in barodynamic methods, the reader need worry little about his mathematics. While he may have assumed that somebody knew enough mathematics and physics to solve all these problems, and while his superior may still think he can solve them, let them both be assured that from a purely mathematical standpoint nobody can.

Probably the first engineers to realize that mathematics and theory alone were insufficient to solve their problems were those engaged in hydraulics. They early saw the necessity for models and it is from them we learned that small scale models might give results which could be translated to full scale operations.

Engineers engaged in ship building followed suit, with models of ships in tanks. The design of the Queen Mary and the last Cup defender were based on tests of model ships in tanks, and the defender's results, over its English competitors, not designed on the basis of such tests, is probably well known.

The people interested in aeroplanes made use of model planes in wind tunnels, and the improvement in flying in the last decade is directly traceable to these tests. In the museum of Science and Industry in New York, one may press a button and watch a model aeroplane in a wind tunnel being lifted by the current of air. In regular testing wind tunnels, instruments are connected to the model so that various measurements may be taken, from which calculations are made as to what the prototype or full scale machine will do.

At this stage the reader has prob-

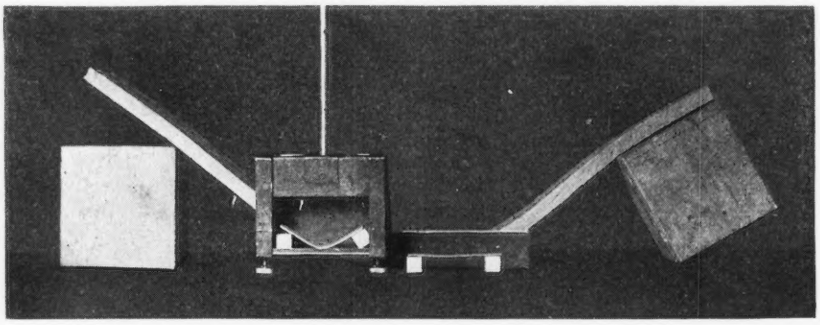

Fig. 1. Under equivalent stresses the small model at left center, when rotated in a hand centrifuge, and the large "structure", or prototype, behind it behaved in similar manner. Both were made of plastic clay. The small model, also of clay, at right center, was subjected to gravitational forces and behaved unlike the prototype

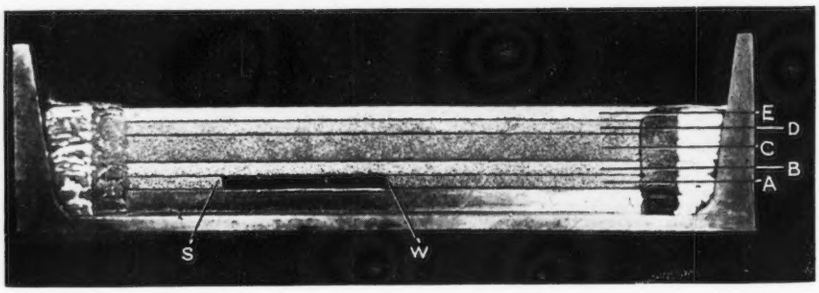

Fig. 2. Model in its holder before being tested in centrifuge. A, ore-body, 3/16 in. constant. B, immediate roof, 3/16 to 6/16 in. C, bed, 6/16 in. constant. D, bed, 3/16 in. constant. E, bed, 3/16 in. constant. S, stationary face. W, working face

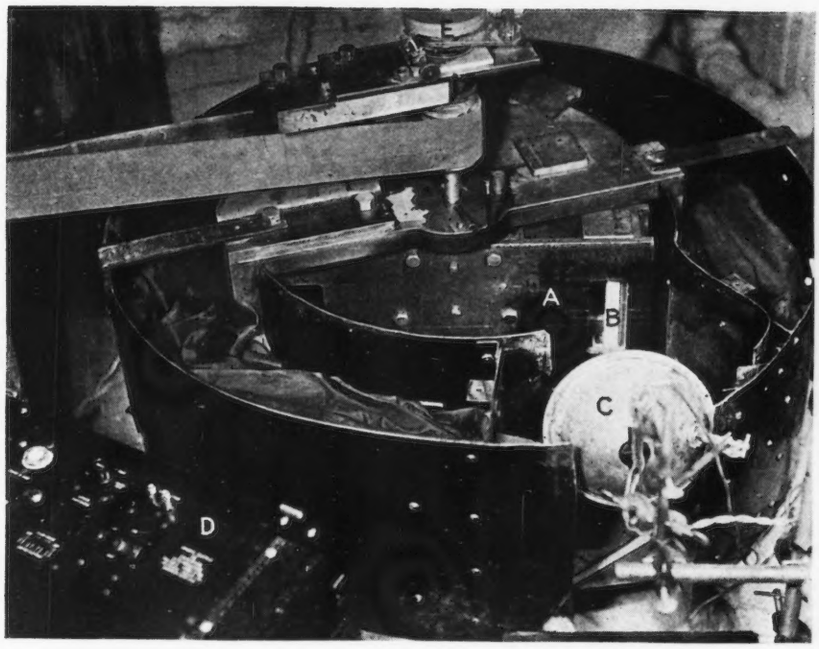

Fig. 3. Centrifuge and motor, with the stroboscopic light and control that permit observation of the behavior of the model as it rotates at high speed

ably guessed that a model in some device is to be suggested as a means of solving many of the mining problems. This device is not a wind tunnel or a tank but a centrifuge.

Use of models to solve mining problems has been suggested previously and often tried, one of those doing so with whom we are familiar being L. E. Young, while the experiments of Fayol are well known to all students of subsidence. The previous difficulty with making model mine experiments of value, from a scientific point of view, was the variety of material to be considered, such as limestone, sandstone, clay, and granite. The hydraulic, aeronautic and naval engineers had only a few factors to consider, which in turn could be limited to one for experimental purposes. We were therefore up against it until about 10 years ago when the following law or principle of similitude was established: "That a model built to scale of the same material as the prototype (full-scale structure) will behave like its prototype within and beyond the elastic limits of stress, if the model weight is increased in the same proportion as its size is decreased. The controlled effect of an increase in weight is obtained by rotating the model in a centrifuge and varying its speed."

This means that if the geologic structure is known, a model of it may be made to any scale, say 1 to 1,000, and rotated at a speed which may be calculated so that the centrifugal force is equal to 1,000 times gravity. While rotating at that speed the model will behave like the full-scale structure.

The significance of this law was readily seen by the physicists, took a little more time for acceptance by engineering professors, and is now being considered by the engineering profession. The law looks and is simple, but making it work was a trying, though pleasant, occupation. A centrifuge had to be built, speed measurement and recording and balancing devices developed, and a means for observing and recording the behavior of the model while rotating found. Everything except the stroboscopic light of Edgerton's was developed in the laboratory. The light device was developed about the time we needed it and was constructed from the inventor's drawings. Equipment was also developed to measure roof sag and bottom heave while rotating, and to make photograph records even to the moving picture record.

The reader probably recalls that at one time he could determine the stresses in all parts of a fixed, simple, cantilever beam, or column with special types of loading. What is more difficult to remember is that the theory and mathematics used applied only if the material was isotropic (had similar physical properties in all directions) and was stressed within the elastic limits. He was not shown how to determine the stresses in beams with partial restraint on a yielding support as mine roofs over pillars, nor in roofs and pillars stressed beyond the elastic limits, nor in mine tunnels, drifts or gangways, nor in a bottom under a pillar. Neither could he determine whether an ore would block-cave, what the block's dimensions should be, and whether he could control the particle size in caving. Suffice it to say that many (not all) of these problems may now be solved, but most of them require not only mathematics but a model as well.

Model and Prototype Dimensions

MODEL RATIO, 1268

Location	Model, In.	Prototype, Ft.
Bed E, surface layer	1/16	19.8
Bed D	1/16	19.8
Bed C	3/8	39.6
Total overburden on roof B	..	79.2
Bed B immediate roof	1/16	19.8
Total cover	..	99.0
Bed A vein being worked	1/16	19.8
Total working face retreat	2.25	238
	2.50	264
	2.75	290
	3.00	317
	3.25	343
	3.50	370
	3.75	396
	4.00	423
	4.25	449
	4.50	475

The process for the development of the model solution procedure was as follows: Inasmuch as the theory of the behavior of simple units made of perfect materials, stressed within the elastic limits (for example, a cantilever or simple beam) is known, the conditions may be determined under which a scale model will behave like its prototype. For example, in models of the same material bending or strain at similar points must be proportional, and the unit stresses at similar points must be the same.

Then, if the model behaves like the prototype within the elastic limits of stress, it may be reasoned that it will behave like the prototype beyond these limits of stress, i.e., within the plastic and through the rupture changes.

Furthermore, if a model of elastic materials behaves like its prototype a model of a plastic material will do likewise. In addition, since the behavior of the model depends upon the manner of applying the load, the load on the model must be applied similarly to that on the prototype. A theoretical analysis will show that the law stated meets these conditions. It thus becomes obvious that a model will bend and break like its prototype and the time of break in the model will be proportional to that in the field.

Establishment of the above means that model experiments may be run to give information as to how a roof will break, whether an ore will block-cave, and how long it will take a roof to fail or block or ore to cave, besides other problems too numerous to mention. In addition, it provides a means of subjecting ideas in mining to test without a large expenditure of time and money or at great bodily risk.

The proof of the pudding being the eating thereof, the first experiments were done with a hand centrifuge shown in Fig. 1, performed before a meeting of the A.I.M.E. and described in detail in A.I.M.E. T.P. 425. The material was a plastic clay roof on

wooden supports, a combination difficult to handle from the theoretical and mathematical standpoints. It may be noted that the model (scale $\frac{1}{8}$) under the action of gravitational forces behaved unlike the prototype. It may also be noted that a similar model rotated by hand in the centrifuge behaved exactly like the prototype. A more ambitious and expensive test was then tried, a concrete beam 90 in. x 20 in. deep x 10 in. wide was then poured and from this same material small 9 x 2 x 1-in. blocks (scale 1/10), were cut. The centrifuge had an $8\frac{1}{4}$ in. radius and the r.p.m. at which the small blocks were to be rotated was calculated at 209. Support was removed from the large block and it failed. The models were then placed in the centrifuge, which was run at the calculated speed and failed similarly.

On careful measuring of the distances between cracks it was found that the results checked within 4 per cent. This is also described in T.P. 425.

Procedure in Making a Model Test. The procedure in barodynamic testing is as follows:

1. Make a study of the geologic structure.
2. From the problem in hand and centrifuge available determine the model scale or model ratio (assumed here as 1268 and the r.p.m. at which it will run 2350).
3. Calculate the data in Table I, i.e., the model dimensions are the prototype dimensions divided by the model ratio (1268).
4. Construct model and place in holder as in Fig. 2.
5. Balance the counterweight in the balancing device provided to give balanced running in centrifuge.
6. Place in centrifuge and bring up to speed.
7. Observe and photograph.

Results of the test are shown in Fig. 4. These data taken from T.P.'s 946 and 1020 show what takes place in longwall mining, a method used for mining coal, iron and gold, under certain conditions, but referred to by other names depending on the material mined. The vein was mined back a given amount, the model then replaced in the centrifuge and run at 2350 r.p.m. The effect all through the geologic structure may be noted with each face retreat and the model at the completion of the test is shown in Fig. 5. All dimensions shown in the figure are obtained by multiplying the model dimensions by the model ratio (1268).

It may not be amiss at this point to point out that a simple model using vein A and roof B alone might have been used to determine a safe span or time effects for room and pillar mining. Complicated geological structures can, in general, be reduced to parts which may be solved with the aid of simple models.

The reaction of many men in the field to this type of research and investigation is probably best stated by Carl A. Peterson of Hudson Coal who also provides the answer in his discussion of T.P. 1020, "Effects of Artificial Support in Longwall Mining as Determined by Barodynamic Experiment," and T.P. 1140, "Photoelasticity and its Application to Mine Pillar and Tunnel Problems." (The author has taken the liberty of making minor changes in the text.)

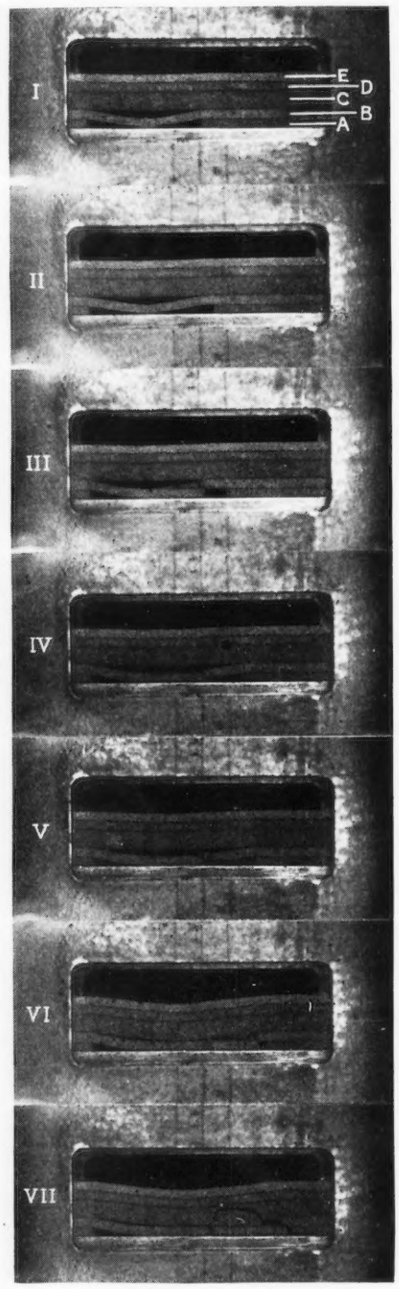

Fig. 4. Results of a test are shown, successively. The model was rotated in every case at 2350 r.p.m. and the model ratio is 1268. B, the immediate roof, is 3/16-in. thick in the model, corresponding to 19.8 ft. in the prototype. The face retreat (the distance of W from S in Fig. 2) in model and prototype, respectively, is as follows for the seven stages: I, 2.25 in., 238 ft. II, 2.50 in., 264 ft. III, 2.75 in., 291 ft. IV, 3 in., 317 ft. V, 3.25 in., 343 ft. VI, 3.50 in., 370 ft. VII, 4 in., 423 ft.

"The first reaction of many mining men to barodynamics has no doubt been that the method will probably work very well for the simple and uniform set of conditions assumed for the laboratory experiments but will fail to yield information of value when applied to the variable and complicated conditions found in the field. That might have been my reaction also if I had not been fortunate enough to have had some field experience which closely agreed with the laboratory findings. At the time when I read his paper on longwall mining a couple of years ago I had just completed the daily supervision of a considerable amount of longwall mining covering a period of three and one-half years and involving more than 6,000 ft. of longwall retreat and the extraction of about 300,000 tons of anthracite coal. For roof support steel props were used which allowed the strata over the mined out area to fall without hindrance, in this respect resembling the condition assumed in the laboratory experiments. I have already stated that my experience in the field agreed closely with the experimental results and will now add that the study of the experimental findings enlightened me as to the significance of some of the phenomena I had observed in the field. This was true even though the conditions in the field were apparently much more complicated and variable than the conditions assumed for the laboratory experiments. I therefore have a strongly grounded belief in the possibility of using barodynamics to aid in solving certain mining problems.

"I would like now to compare briefly at this time my observations of longwall work in the field with Professor Bucky's laboratory findings.

"1. He concluded that the minimum length of longwall face should be preferably at least five times, and in no case less than one and one-half times, the span at which the overweight will fail as a beam. I am not able to say at what length of span the overweight failed in the longwall work which I observed in the field, but I can state that under the conditions which prevailed, a longwall 360 ft. in length worked very successfully, while shorter lengths of face gave considerable trouble. In one case, due to convergence of two gangways, a longwall of decreasing length was worked, and as the length decreased, trouble began to be experienced because the roof would not break and therefore threw excessive weight on the steel props and the longwall face. This condition became so bad that when the length of face decreased to 120 ft., the longwall method of working had to be abandoned. This agrees with the conclusion that for a given condition there is a minimum length of longwall which can be satisfactorily worked. My observations also lead me to believe that there is a relationship between the span at which the overweight fails as a beam and the minimum suitable length of longwall face. However, due to the fact that I have had no opportunity to make precise observations since I read this paper, I cannot say how closely his

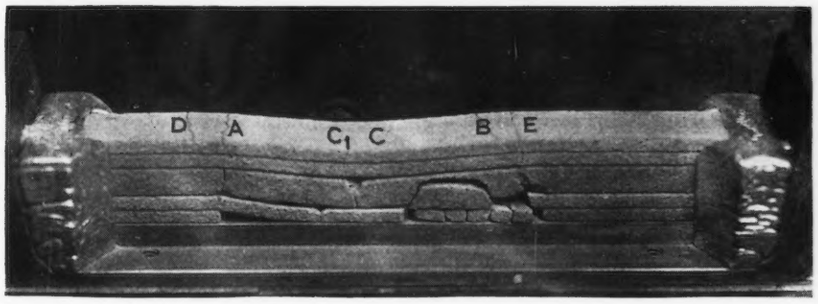

Fig. 5. Model after longwall test. D, A, C_1, C, B and E mark position of surface cracks

numerical ratios agree with an actual case in the field.

"2. A cyclical variation in roof pressure was characteristic of the longwall work in the field. This conforms with his observation of periodic failure of the overweight and his photographs of stressed models make the reasons for this cycle clear to us instead of a matter of conjecture as it formerly was. In practice we found that there was a certain phase of the cycle when a longwall face could be safely stopped and allowed to stand for an indefinite period of time, which also agreed with his conclusions.

"3. His conclusion that desirable longwall conditions are a thin, strong underweight and a thick, strong overweight also agrees with my field observations."

The mining plans of most stope and pillars as room and pillar mines call for rooms and stopes of a constant dimension. On a recent examination study and tests of a coal mining property, the laboratory results showed that in certain sections of this mine the room span should be 24.8 ft. The present practice is to have 24-ft. rooms, which was arrived at on the basis of practical experience. The tests and study also showed that large areas could have 40-ft. rooms and other areas 60-ft. rooms. The change in room span was due not so much to variation in roof strength which was less than 10 per cent, but to variation in roof thickness and overburden. It brings home the interesting point that in these days of mechanization a knowledge of what can be done in each portion of the mine will have significant effects in costs and profits.

A succeeding article will endeavor to explain barodynamics more fully and show how some interesting new physical tools and ideas may contribute to the advance of our mining industry.

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An Iron Discovery at Zeballos

MAGNETITE IRON ORE discovered in the Zeballos district, Vancouver Island, two years ago, is dealt with in a preliminary report by John S. Stevenson, recently issued by the British Columbia Department of Mines. The property, known as the F. L. iron property, consists of six mineral claims, the F. L. and the F. L. Nos. 2 to 6 inclusive. These were staked in June, 1939, and are owned by A. W. Ford and his associates, of Zeballos, B. C. The claims are on the northwest side of Zeballos River and extend across the headwaters of Black Sand Creek, a tributary of Granite Creek.

The property may be reached by following the Zeballos River road from the beach for 4 miles to a suspension foot-bridge across the Zeballos River. From here, at an elevation of approximately 175 ft., a foot trail extends for 1½ miles past the Maquinna property to the Torres Zeballos property, at an elevation of 1,300 ft. From the Torres the showings are reached by an indefinite route that leads for approximately three-quarters of a mile northeastward up the steep mountain side to the claim posts on the lowermost showing, at an elevation of 2,400 ft.

The showings extend between elevations of 2,400 and 2,850 ft. and consist of bluffs of magnetite on the steep mountain side sloping 45 deg. into the creek. Hemlock and cedar alternating with open areas of nearly vertical bluffs cover the hillside. The magnetite bluffs are cut transversely by one major canyon and three minor ones.

The deposit consists of a lenticular body of relatively pure and continuous magnetite that has replaced part of a limestone kidney enclosed in greenstone. In it the rocks consist of crystalline limestone, andesitic greenstone, and feldspar porphyry dikes. The limestone is free from observable impurities. In its thickest part the kidney is approximately 200 ft. thick. Andesitic greenstone occurs both as dikes cutting the limestone and that part of the limestone kidney now represented by the magnetite, and as ¼-in. elliptical amygdules of calcite scattered in the greenstone. The feldspar porphyry occurs as dikes 6 to 25 ft. wide cutting the limestone, greenstone, and magnetite. No displacement has occurred along these dikes.

The mineralized body consists of a large lens of relatively pure magnetite in which lime silicates are practically non-existent. In general the magnetite is massive and fine-grained. In places more crystalline phases do occur, the grain size ranging from ⅛ in. to ½ in.

Mr. Stevenson interprets the structure as a northwesterly striking anticline, overturned to the southwest and with no appreciable plunge. A small part of the core of the anticline is exposed on the easterly wall of the canyon of Black Sand Creek, and the trace of the easterly limb as marked by the contact between the magnetite and limestone extends northward up the hillside.

The magnetite body occurs along the crest of the anticline, with greenstone above and limestone below. It extends down the limbs on either side but appears to die away from the crest as shown by the ends of the exposed lens.

For estimating tonnage Mr. Stevenson bases his calculations on paced measurements made along the foot of the magnetite bluffs, taped measurements made across the magnetite body in the beds of No. 1 and No. 2 creeks, aneroid readings on the three most southerly bluffs, and visual estimation of the width up unsealable bluffs. His figures are as follows: For the portion south of Black Sand Creek—aggregate length of exposed magnetite, 1,040 ft.; thickness of lens measured in Nos. 1 and 2 creeks, 101 ft.; depth as calculated from slope measurements in Nos. 1 and 2 creeks, 55 ft.; assuming a specific volume factor of 7 ft. per ton, the tonnage is 825,314. For the portion north of Black Creek, a length of only 200 ft. is assumed for estimating the amount of high-grade magnetite, isasmuch as greenstone inclusions and calcium silicates become abundant in the magnetite beyond this distance, and the tonnage arrived at is 158,714. Total for both portions is 984,028 tons, or 17,891 tons per foot of depth.

For estimating possible tonnage, Mr. Stevenson uses the same lengths and thickness, but takes a depth of 80 ft. for the downward extension inferred from measurements at the south end of the lens, this giving a tonnage of possible ore of 1,425,840.

The grade of magnetite is indicated by the following analyses made by the Mines Branch, Ottawa, on a 200-lb. sample taken by Mr. Stevenson at random along the magnetite bluffs by associates of Mr. Ford: Fe, 67.76 per cent; TiO_2, 0.09; S, 0.10; P, 0.001; and SiO_2, 1.05. Analyses of four small samples taken by Mr. Stevenson at four widely spaced intervals along the length of the magnetite lens showed iron ranging from 67.5 to 68.7 per cent, sulphur 0.06 to 0.3, and phosphorus from a trace to 0.01. In each case there was only a trace of TiO_2.

Safety at Climax

The Molybdenum company makes it a major consideration, on a par with other phases of its operations, with excellent results

James K. Richardson
Safety Director
Climax Molybdenum Company
Climax, Colo.

RECOGNITION has long been accorded the principle, among far-seeing executives as well as safety men, that all safety programs to be successful must be based on the premise that management must be sincere in its efforts to get results from such a program. This means that everyone in the management and supervisory group must believe in and *want* a safe operation. If there is a "weak link" in the chain of command, from president to jigger boss, the program can reasonably be expected to fail at that point, the reason being that safety will not be pushed below it and the success of the program is definitely determined by how much enthusiasm is shown by the supervisor actively in charge of the working man. Every boss's safety record is a direct reflection of his interest and enthusiasm in the work. Unless this principle be observed by all operating supervisors, no amount of effort or planning can produce other than a superficial semblance of a safe operation.

The policy of the Climax Molybdenum Company in respect to this has been definitely outlined and set down in print. The written statement has been distributed among employees and supervisors, and can be found in the foreword of the Company's safety manual. The following paragraphs are quoted from it:

"To Our Employees:

"At the start let us have an understanding that the policy of the Climax Molybdenum Company is safety first and always.

"Things well done are safe. The safe way is the best way. The man who does not perform his work with the utmost safety to himself and others is neither a good nor a desirable workman; and no job is completed until it is as safe as it can be done.

"The Climax Molybdenum Company has done in the past, and will continue to do in the future, everything in its power to prevent accidents and injuries to its employees. Every encouragement is given by the company to make working conditions safer and better. To this end, the management will appreciate any suggestions from its employees. This company will spare neither effort nor expense in complying with the recommendations of the Safety Council or employees regarding the safest methods of doing the work, and regarding the installation of equipment and devices which would give the greatest degree of safety to all its employees. This policy will be continued, and it is hoped that each employee will consider himself at all times a safety inspector, and will report immediately any dangerous places or practices in his workingplace or anywhere about this property.

"Many accidents and injuries are caused by carelessness or recklessness of the workman himself. It is a duty every man owes to himself and to his dependents to avoid danger at all times, and to be careful and cautious in his work. A careful workman is generally a good workman. It is self-evident that anyone who is unable or unwilling to comply with our safety requirements should not be retained in the company's service.

"While we wish to impress upon you that failure to comply with these rules will not be tolerated, we also as forcibly wish to bring to your attention the fact that willing and hearty cooperation along the lines of safety will be appreciated. We want this to be the safest mining property in the world; and we know that you would prefer to work in the safest property rather than to work at a property where workmen are allowed to carelessly endanger their own lives and the lives of their fellow-workmen. Everything possible will be done to help each workman to be a safe workman; but if these efforts fail, and any workman insists on taking chances, he will be asked to seek employment elsewhere.

"The following rules and suggestions have been prepared that the workman may learn to avoid dangers of his occupation and do his share in the work of accident-prevention. They ought to be carefully read, thought over, and discussed. A suggestion found in this book may someday keep you from a serious accident."

The policy, as outlined, is definite and positive. Naturally, the first thought is, "Is it followed?" We do not think that the trend of our frequency rate would have held steadily downward if the making of this statement had been an idle gesture. The accident frequency rates referred to are given:

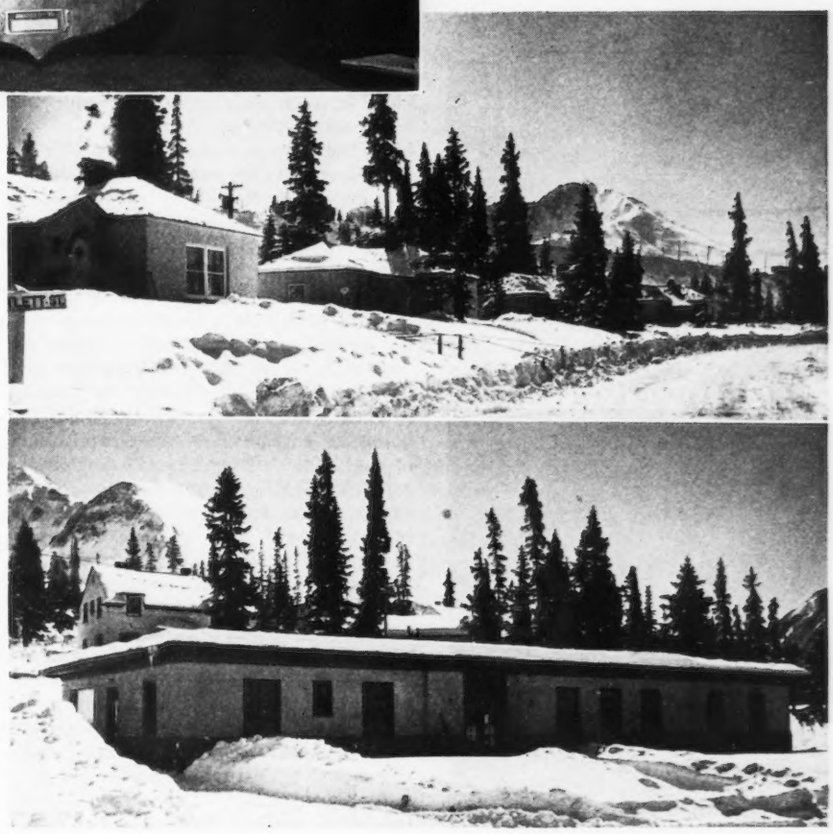
Year	*Accidents per Million Man-Hours Worked*
1930	179.04
1931	166.38
1932	132.39
1933	157.67
1934	172.87
1935	44.85
1936	23.27
1937	21.71
1938	19.41

I have long contended that the true picture of the efficiency of a safety program could be seen in a frequency record. Considerable disagreement upon this point exists among safety engineers, some of whom maintain that severity is the proper basis. Much can be said in favor of this; the thought constantly recurs, however, that severity is more or less a matter of luck. In the final analysis, it can be said

Portal of the Phillipson tunnel, main entrance to the mine

The President's Trophy, presented annually to the unit with the best record. It was awarded to the Mining Department in 1939. Left, J. R. Sweet, mine superintendent; right, C. J. Abrams, general superintendent

Typical winter scene at Climax, showing modern homes of employees. The elevation is 12,000 ft. above sea level. Below this picture, the hospital of the Climax Molybdenum Company, at Climax



that if you cut out accidents you cut out severity. By the same token, a low frequency certainly reduces the chance of severe accidents.

For any safety program to function properly it must be realized that the shift boss is really the man who makes a safety record. Despite company policy, if he is careless or indifferent, he can do more damage than a corps of safety engineers can undo. Our first act was to weed out those individuals on our supervisory payroll who could not be convinced that safety and production were intimately interlocked. Some were doubtful as to this but the results achieved in accident prevention were almost paralleled by those obtained in production: the better a foreman's safety record, the better his tonnage-cost record. This convinced the skeptics.

Our policy regarding supervisors is to take each of our underground shift bosses and give him six months' training in the Safety Department. He must complete this period successfully before he can be promoted to a divisional foreman's job. During the six months he acts as a safety inspector for the entire mine; he trains his first aid groups; makes out safety reports and statistical studies; studies present practices and recommends changes. He is divorced from all other duties. The value of this training is inestimable. Not only does the shift boss thus get a picture of the work of the Safety Department at first hand but he obtains a clear idea of every foreman's operating problem. He learns how essential cooperation between bosses is to the success of the entire operation. Normally he would see only his small province and have little opportunity to learn how the other fellow handled problems like his own; but by visiting all divisions he gets new ideas.

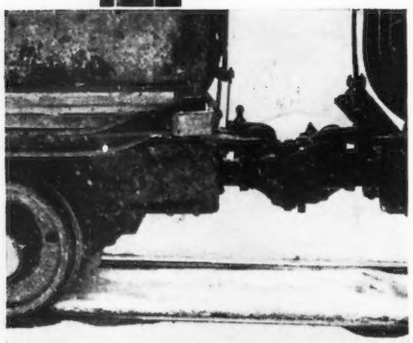
The mine is divided into four divisions, each headed by a foreman. Under the foremen are shift bosses and in some of the larger territories a jigger boss is under the "shifter."

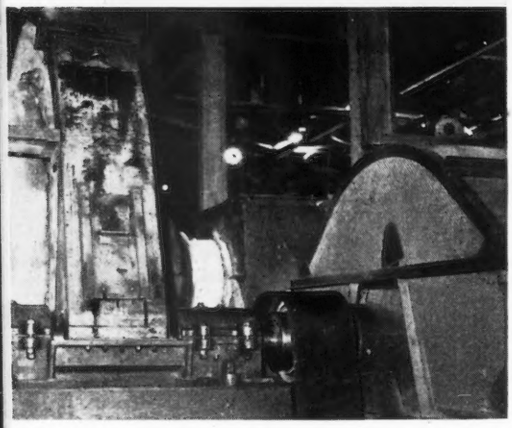
Annually a safety competition is held between the various shifts, the prize for the best record being a handsome plaque which becomes the permanent property of the winning shift. Each of the shifts is intensely proud of its record and all work for the trophy. The trophies are hung in the mine lobby beside the shift bosses' window for each man to see. Each foreman vies with the others to see how many plaques he can win for his division.

This competition is carried out also in each unit of the plant. A departmental contest is conducted for a large trophy presented by the president of the company. Each department is handicapped according to its previous record and the one showing the greatest improvement during the contest year over its record for the previous year is declared the winner. All trophies and plaques are presented in a general mass meeting to the winners by some ranking official of the company.

We cannot emphasize too much the importance of the supervisor in the program. Here, he is held directly responsible for his accidents. We have long maintained that a supervisor with a fair production record and a bad record as to safety is not one to be advanced. If over a period of time his safety record fails to improve, such a boss knows that he will be replaced. In all cases, a safety record is given a par standing with a production rating when a man is given a promotion.

The competition mentioned has been long considered an active stimulus to the safety movement. The competitive spirit engendered has good results; however, unless things are closely watched the results obtained can be misleading. Too much enthusiasm may result in a supervisor hiding an accident to improve the record. Such a





Top—Safety belts are used on construction work. This steel was erected during winter months with temperatures as low as —20 deg. F. Center—Automatic car couplings, safety chains, and air brakes are used in underground haulage. Such precautions have reduced haulage accidents to a negligible figure. Bottom—The means employed to guard this ball mill and motor at the Climax concentrator are characteristic of the operations

practice not only distorts the picture of the accident trend but also works hardship on the injured person.

Probably the second most important phase of a safety program is that of educating the men to think and act safely. The methods used are fairly standardized in accord with the best authorities on this subject.

We hold a monthly meeting of all department heads. These men guide the general program. It is upon their interpretation of the company's safety policy that the program is based. This meeting is presided over by the General Superintendent.

Every fifteen days some departmental meeting is held which is attended by all the supervisors in that department. At this meeting the department head presides.

Monthly a meeting of the underground employees is held in their underground lunchroom, under the chairmanship of their boss. This appears to be extremely valuable in that here the men themselves have an opportunity to take an active part.

The safety engineer keeps and distributes the minutes of all these meetings. For any of them to have real value, the suggestions offered must be acted upon and not allowed to "hang fire." Prompt action by the management upon these suggestions tends to make all employees realize how valuable their help is to the program. They feel, then, that the management is sincere in its efforts.

Attractive bulletin boards, well lighted and maintained, are placed at various points throughout the camp. The Climax company is a member of the National Safety Council and posts its bulletins. This service is supplemented by that of the Elliot Service Company with its posters and news pictures. The service of the bulletin board is extended as an educational appeal in that notices as to sports and work can be found on it. This, naturally, makes more readers. An unattractive board with material that is never changed is seldom looked at more than once. We have also installed a public address system whereby we can call special notices to the men's attention; give safety talks; or broadcast news events of interest. This feature must be used as carefully as a commercial broadcast. The safety appeal must be interesting and brief and interposed within the general program.

As mentioned earlier, we have printed a "Safety Manual" which lists the policy of the company with regard to safety, and informs the employee of the rules governing his job. This manual is given to each new man when he is hired. One week later he must report to the safety engineer and pass an examination on these rules. Employees, moreover, are questioned regarding the rules as the safety engineer makes his round.

During the past six years the Safety Department has trained approximately 2,000 men in first aid. This training conforms to the standards set up by the U. S. Bureau of Mines. There are 20 qualified and certified first-aid instructors among the men. The training is generally carried out during the summer months. Interestingly, during these periods there is a noticeable decrease in all accidents, presumably brought about by this training.

Our men are encouraged to make suggestions outside of their meetings. At different points paper and pencils are found hung from small receptacles called suggestion boxes. For the best suggestion made each month a prize of $5 is given. Smaller prizes are given for other suggestions deemed worthy of action. In all cases, each suggestion received is carefully considered and, if rejected, we are careful to see to it that the person making it knows why it was turned down.

A successful safety program must have allied with it a successful scheme for discipline. Discipline is essential so that the bosses and other employees may realize that the written rules and the unwritten ones of common sense are meant to be carried out. A book of rules cannot be expected to cover every situation; to a large extent any company must depend upon the native intelligence of its men. However, no rules should ever be made that are unenforceable or which are not intended to be enforced. Safety rules are basically common sense; and if a man stops to think before acting, normally he will follow them. When they are deliberately violated, however, definite disciplinary action must be taken. Here, every instance of safety rule violation is referred to a grievance court. Sitting as permanent judges are the personnel manager, the assistant mine superintendent, and the safety director. The complete record of the offending employee is available for study prior to rendering a decision in the particular case before them. An honest attempt is made to study the individual's background so that the penalty imposed is just and fair. Should the offending employee's record indicate that he is a chronic offender, he will ordinarily be discharged. Usually, however, a real effort is made to rehabilitate the man. In most rehabilitated cases these men eventually become safe and conscientious workers.

Before an organization can thoroughly exercise its disciplinary policy, it must have its "house in order." That is, every operation, machine, and tool must be in good condition and safe to use. Then a positive request to cooperate can be made and compliance expected. When a man sees that you are serious in your attitude towards safety, his natural inclination will be to help. But you must convince him.

Physical examinations for the new employee as well as for the "old timer" have been found of great value to our safety program. Work at high altitudes is certainly no place for persons with weak hearts or pulmonary troubles. Men who work underground should have better than average hearing and eyesight. With a definite medical policy we are able to weed out applicants who are not physically equipped for work here and assure the proper placement for those we hire. Examination of an old employee sometimes discloses that his present placement is wrong. He is then changed to a job in keeping with his physical condition. Thus we maintain high health standards among the men.

We have distributed to each of our foremen a copy of the State Mining Laws and a copy of the "Industrial Standards." We have done this so that every new job completed will be properly guarded and in accordance with the laws governing our operation. The purchasing department specifies on all purchases that equipment be guarded according to industrial standards. We have found that the guards thus supplied are cheaper and superior to those made at the plant. It should be pointed out that most reliable manufacturers supply guarded equipment without this notification. So far as possible we have standardized every operation so that the work can be safely and economically done. Every attempt has been made to make jobs and machinery "fool-proof."

Underground our ventilation system is carefully watched by a ventilation engineer. The system used is a vacuum one, with three fans; an 8-ft., two-stage Aerodyne; a 7-ft. Aerodyne and a 6-ft. Aerovane acting as exhausting units. One 6-ft. and a 4-ft. Aerovane are installed as booster units. A 7-ft. Aerovane acts as an intake unit delivering air directly to the haulage level. In addition, we employ a large number of auxiliary blowers of the Coppus TM-6 type. These are used mostly in dead-end drifts and rises. The fixed units have a present working capacity of 373,000 c.f.m. This tremendous volume is necessary as our mining method requires a certain amount of blasting during the shift.

The mining method used is more or less a standardized caving system similar to that employed at a number of the larger mining properties where large orebodies are worked. The ore is undercut by driving inclined raises under the block being mined. "Dog holes" are run through the pillar dividing the undercut raises leaving approximately 12x12-ft. pillars. When the undercutting is completed the pillars are "long-holed" and blasted out in a retreating method. The last to be blasted are those over the draw points. The ore then caves due to the height and weight of the block. In our grizzly system the caved ore first comes to the grizzly, thence to the chute raise below from which it is loaded into cars. In our slusher system the rock caves directly into fingers leading off the slusher drifts which run at right angles to the loading drift. This ore is slushed by dippers into a hopper directly above the cars. The size of the rock can be imagined when it is realized that the grizzly rails are spaced from 30 to 36 in. apart. Bulldozing is necessary both on the grizzlies and in the slusher drifts. To all appearances, the grizzly system appears more hazardous than the slusher system but we find no particular difference when the two are compared over a period of three years. If large rock is handled blasting is necessary.

The greatest hazard from explosives is that which exists when blasting in the chute raise or on the grizzly. We have installed warning "squawkers" in series so that when grizzly blasters are shooting they can warn the loaders and vice versa. Cables servicing these "squawkers" are run through diamond-drill holes between haulage and grizzly levels. All blasting on the grizzly level is done electrically, using hand magnetos to eliminate the possibilities of "live" shots dropping down the chute raise and endangering the loader.

Dynamite is handled and stored in accordance with the recommendations of the Association of Explosives Manufacturers and the State Mine Inspector. Only enough is taken underground to last 24 hours. This is carried inside in a specially built car in a separate train between shifts. The main dynamite magazine is outside and is a tunnel with three right-angle offsets in it. Chambers for the magazines have been constructed off this tunnel.

Blasting "hangups" in the chute raises, grizzly and slusher fingers present our biggest problem. Normally, these are blasted by using "sky rockets" or bundles of dynamite tied upon a 1x2-in. stick which varies from 12 to 20 ft. in length. Instantaneous caps are used on the grizzly level, but in the others 5 ft. fuse is used. The fuse is stapled to the stick and a "pull-wire" fuse lighter is attached. To the lighter is tied a long string, so that when the bundle is in place and securely wedged in the side of the raise, the fuse can be ignited. We allow no shots to be placed with the fuse burning. A burning fuse hurries a man and he is likely to overlook some important detail and trap himself. In no case is a loader or bulldozer allowed to go under the hangup. If the hangup cannot be reached by a stick shot, he must report to his boss for instructions. Normally the boss will attempt to loosen the hangup by concussion; in rare cases he may go up under it to place a shot. We realize that we have not entirely eliminated the hazard from this source, but we have materially reduced the exposure.

Falls of ground are a prolific source of accidents in all metal mines. We have virtually eliminated this cause by the plentiful use of timber and by cementing bad places. In the stopes each miner has a bar and is required to use it before doing any other work in the face. We have made it a serious offense to be found working in a place where back or sides show loose rock.

Haulage, normally, makes for numerous accidents. By maintaining excellent track and carefully inspecting and replacing faulty equipment we have reduced the number from this source to a negligible figure. The haulage drifts are kept clean so that stumbling near trains is rare, and derailments due to debris are few. Trolley lines are in all cases at least 9 ft. above the rail, and in manway areas they are guarded. Rubber sleeves are used over the trolley in all places where men must work near them. All trains are dispatched in and out of the mine. Granby-type cars are used.

All in all, the company has adhered to its policy as outlined earlier in this paper. This has not only paid dividends from a monetary standpoint, but has materially helped in our public and personnel relations. The labor turnover has been reduced to a figure where it compares favorably with operations where climatic conditions are better. At present about 88 per cent of our mine employees have been continuously in our employ for over two years. This fact, in itself, is an aid to safe and economical work.

The management has definitely placed safety on a par with other phases of the operation. The money spent in preventing accidents is as necessary and of as vital importance as an expenditure on any other operating problem. A good safety record implies good management and under normal operating conditions the cost curve follows the frequency curve.

The General Safety Committee of the Climax Molybdenum Company

A typical bulletin board that is in use at the plant

Cut-and-Fill Stoping at Arizona Magma

As described by the late George G. Wald,[1] former superintendent of the Arizona Magma Mining Company, at Chloride, Ariz.

THE ORE of the Arizona Magma mine, near Chloride, Ariz., occurs in quartz veins which strike northwest to southeast through a granite country rock injected with basic dikes. The dip of the veins is 60 to 70 deg. They vary in width from a few inches to sixteen feet or more. The vein filling, though usually quartz, may be massive or recemented breccia. The ore occurs as sulphide pay streaks on foot or hanging wall or both and as lenses and kidneys of sulphide in the vein usually parallel to the walls, or on adjacent walls back of false walls.

Predominating minerals are pyrite which carries the major part of the gold, and proustite and pyrargyrite which carry the silver. Galena, also argentiferous, occurs sparingly; the concentrate contains only 3 per cent lead. Zinc blende and marmatite are present in small amounts, but so far have been found to carry practically no gold and silver values.

Vein walls are usually granite schist, though sometimes they are chlorite or minette. Basic dikes are also found injected into the vein itself. On both the hanging wall and the foot wall is a talc gouge varying from nothing to eighteen inches in thickness. When wet it becomes slippery causing slabs to scale off. Often this talc seam is a false wall, sometimes concealing ore.

The average vein is half valueless quartz and half sulphide or mineralized quartz. This condition particularly adapts these veins to the cut-and-fill stoping method because the ore in place when broken doubles in volume. The waste when sorted out fills the stope to a convenient working level. If there is too much of it, it has to be trammed from the chutes and disposed of either as gob in the stopes on the level below or hoisted to surface. This condition has not yet been met and will be rare. On the contrary when the vein itself does not provide sufficient waste, prospect raises are put up in the foot and hanging walls. This provides the waste fill incidentally, but primarily it eliminates the possibility of passing up lenses of ore or parallel ore chutes back of false walls. If the pilot raises do not supply enough waste they can be used as a transfer in bringing gob from the level above.

Originally the ore was mined by a combination square-set, stull-stope method. A block of ore 30 to 50 ft. long was mined out 100 ft. between levels before gobbing. This method worked satisfactorily, but the rising cost of timber made it essential to change to a more economical system. The cut-and-fill method was therefore adopted.

The vein is opened up by levels 100 ft. apart. Drifts in country rock are not timbered. Those on the vein are timbered with sets on 5 ft. centers at the same time that the drifting is done. Tight timbering is necessary to prevent the walls from sloughing. Oregon pine, 8x8 in. in size, is used for posts and caps and 4x6-in. pieces for collar braces. The sides are lagged with 2x12-in. material when necessary. When the drift sets are put in in potential stoping ground, 8-in. squeeze blocks and an 8x8-in. Oregon pine bridge are put in over each drift cap (Fig. 1). Later, two-compartment cribbed pilot

[1] This manuscript has been received through the courtesy of Mr. Wald's son, Edwin Wald, 301 N. Valencia St., Alhambra, Calif.

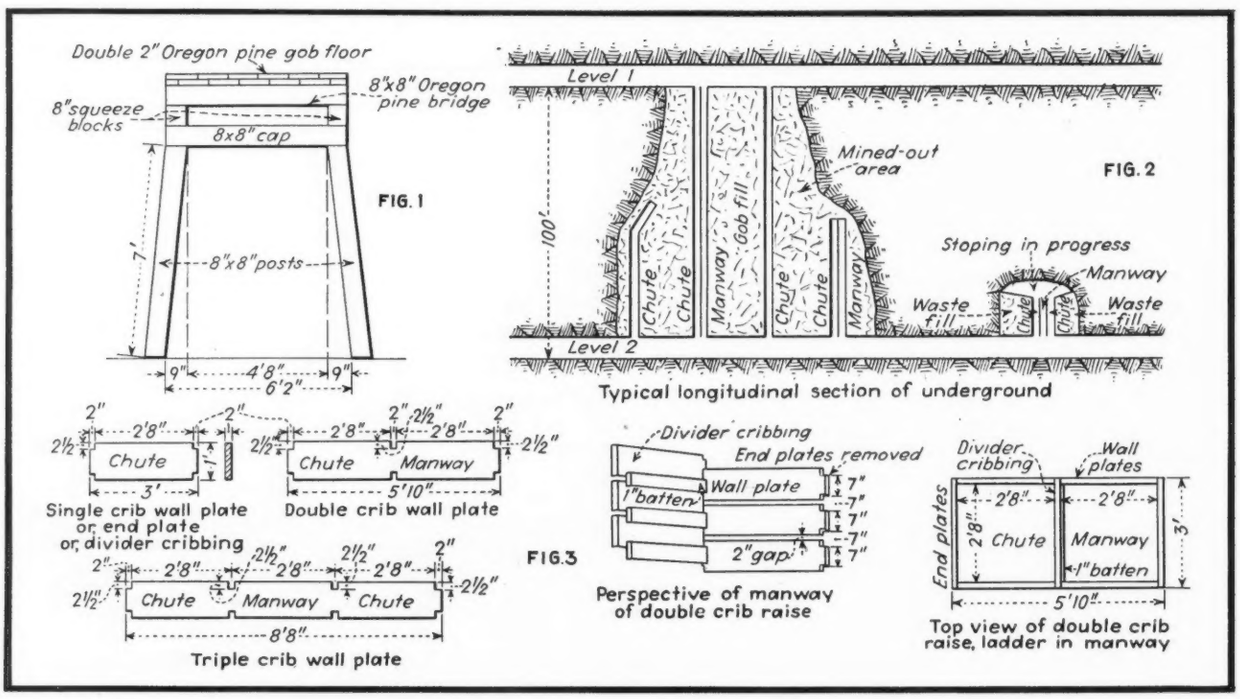


Fig. 1. Idealized cross section of drift timbering in potential stoping ground. Gob floor is put in when stoping is started. Fig. 2. Typical longitudinal section of mine illustrating the stoping method used. Fig. 3. Details of chute and manway timbering

raises on 50 ft. centers are put up to the level above.

When active stoping is started, the first round above the bridge is drilled and shot down on a deck which is high enough to pass a mine car. A double gob floor of 2-in. Oregon pine or a single floor of 3-in. boards is then laid on top of the bridges and the second round goes into the chutes. Chutes are spaced on 25-ft. centers; manways on 50-ft. centers (Fig. 2). These are carried up as the stope and fill advance as single, double or triple crib raises. Each compartment is 2 ft. 8 in. x 2 ft. 8 in. inside in the clear. Green native Arizona pine, 2x12 in., has proven amply strong for the temporary chutes and manways in ordinary stoping, but for permanent manways and chutes 3-in. stuff is preferable. For the double- or triple-compartment crib raises the wall plates can be notched and framed for the full length of the raise, using 2x12-in. cribbing set in for the dividing walls between manway and chutes. This leaves 2-in. spaces between the divider cribbings which have to be battened with 1-in. plank to render the manway safe (Fig. 3).

The back is drilled so that the waste will break as coarse as possible, to facilitate sorting. Sometimes the ore and waste can be shot down separately. In either case the rock is blasted down on a plank floor laid on top of the waste gob. The ore is then shoveled into the chute, and the waste is worked back to be used for fill. The stope is carried up in this manner to the level 100 ft. above. The early disposal of the waste eliminates unnecessary handling and provides a mill head that has been found to be correspondingly higher in grade.

Smelting Domestic Chrome Ores In the Electric Furnace

The Bureau of Mines reports on its investigation of high-iron concentrates from Montana and Oregon made to determine chromium recovery, power consumption, and grades of products possible by electrothermal reduction

ACCORDING to G. E. Seil,[1] the United States consumption of chromite is distributed as follows: Metallurgical, 50 per cent; refractory, 40 per cent; and chemical, 10 per cent. According to J. W. Furness[2] in I.C. 6038, the average grade of ore consumed in the United States during the last war period was 41 per cent Cr_2O_3.

The domestic chrome ores from Montana and Oregon which are being investigated as hereinafter described can be concentrated by gravity to the same grade metallurgical Cr_2O_3 as used during the last emergency period. These concentrates have a chromium-iron ratio of 1.7; high-grade imported metallurgical ore has a ratio of 2.5. The following account of the investigation is as given (with some excision) in a paper presented by R. G. Knickerbocker, M. B. Royer, and T. E. Evans, of the staff of the Metallurgical Division of the U. S. Bureau of Mines, at the dedication of the Bureau's new experiment station in Salt Lake City, Utah, on May 21, 1940.

This investigation was undertaken to demonstrate in small electric pilot furnaces: (1) the chromium recovery, (2) the power consumption, and (3) the grades of chromium products possible by several electrothermal methods of reduction as applied to domestic high-iron chromium ores.

[1] Seil, G. E., "Chromite," Industrial Minerals and Rocks, 1937, A.I.M.E.

[2] Furness, J. W., The Chromium Situation from a Domestic Standpoint, Bureau of Mines, I.C. 6038, 1937.

TABLE I. Standard Power Consumptions

(A. G. Robiette, "Electric Smelting Practice")

	6 to 8% Carbon Alloy	4 to 6% Carbon Alloy
Power consumption per ton of ferroalloy	5,500 to 6,000 kw.-hr./ton depending on furnace size	6,500 to 7,000 kw.-hr./ton
Recovery of chromium	90 to 95%	75%

Standard Ferrochrome Electric Furnace Practice. Ferrochromium—3 to 10 per cent carbon. The chromite ore or concentrate used usually analyzes 40 to 55 per cent Cr_2O_3 and 12 to 18 per cent FeO, the rest being principally alumina, magnesia and silica. This standard

(Continued on page 50)

TABLE II. Prices of High- and Low-Carbon Alloys, July, 1934

	8 to 10% Carbon	0.7% Carbon
Per ton ferroalloy	$101.85	$203.70

TABLE III. Jigging Minus 20-Mesh Unsized Unclassified Ore

	% Cr_2O_3	% FeO	Cr/Fe Ratio
Heads	27.16	16.6	....
Concentrates (average)	43.2	22.6	1.68
Tails	....	....	....

TABLE IV. Results of Pilot Plant Table Concentration

High-grade fines, 12-27-39

	% Cr_2O_3	% FeO	Cr/Fe Ratio
Heads	24.4	15.9	1.35
No. 1 concentrate	38.3	19.5	1.70
No. 2 concentrate	41.98	20.9	1.75
No tails on No. 1 table			
No. 2 tails	2.02	7.83	....
Classifier overflow	10.4	10.4	....
Slimes loss	....	....	....

TABLE V. Results of Pilot Plant Table Concentration

Low-grade fines, 12-28-39

	% Cr_2O_3	% FeO	Cr/Fe Ratio
Heads	10.80	12.4	0.78
No. 1 concentrate	38.0	20.0	1.72
No. 2 concentrate	41.84	22.4	1.65
No tails on No. 1 table	....	....	....
No. 2 tails	3.62	8.25	....
Classifier slimes	9.40	11.08	....

TABLE VI. Montana Chromite Direct Ore Smelt. 12-26-39

	Sample No.	Analysis Cr_2O_3	FeO	Al_2O_3	MgO	SiO_2	Ratio Cr.-Fe
Charge	15,024	25.6	15.4	11.3	21.2	20.4	1.52
Slag	15,032	9.4 Cr	3.6 Fe	20.6 C	36.4	32.4	2.30 (a)
Metal	15,033	49.5	41.1	7.9	....	....	1.20

(a) This slag contained appreciable metal shot which did not settle under these casting conditions, i. e., viscosity, speed and volume of pour. The temperature of the slag by optical pyrometer was 1664 degree C. The loss of chromium in the slag is 23 per cent of the chromium charged.

TABLE VII. Montana Chromite Direct Ore Smelt. 12-29-39

	Sample No.	Analysis, % Cr_2O_3	FeO	Al_2O_3	MgO	SiO_2	Ratio Cr/Fe
Charge	15,024	25.6	15.4	11.3	21.2	20.4	1.52
Slag	15,040	1.45 Cr	2.78 Fe	25.2 C	38.1	29.4	0.46 (b)
Metal	15,039	53.7	35.1	7.7	....	....	....

(b) The total time of charging, smelting and casting was 20 minutes longer than in Table VI. The positions of the electrodes were controlled so that the slag and charge were hotter during the smelting period than in Table VI. Optical pyrometer temperature in Table VII before pouring slag was 1680 degree C. The metal was also at a higher temperature than that in Table VI, which is shown by the fluxing of the chromite lining in the hearth of the furnace.

The loss of chromium in Table VII run slag is only 3 per cent of the chromium charged.

TABLE VIII. Montana Chromite Gravity Concentrate Smelt. 1-29-40

	Sample No.	Analysis, % Cr_2O_3	FeO	Al_2O_3	MgO	SiO_2	Flux Silica Added	Ratio Cr/Fe
Charge	15,054	40.4	19.6	16.5	15.1	5.7	13% of charge	1.75
Slag	15,065	1.95 Cr	3.8 Fe	....	....	25.5	....	0.4
Metal	15.067	54.8	33.3	....	....	....	....	1.7

TABLE IX. Ferroalloys Produced by Varying Carbon on Charge

Per cent carbon* on the charge		14	16	18	21	23	26	28
Per cent analysis of the ferroalloy	C	0.30	0.55	1.0	1.9	4.1	6.2	
	Cr	40.1	56.0	65.4	69.0	68.5	67.7	
	Fe	59.3	43.2	33.0	27.5	25.3	24.5	
Yield of chromium in the alloy (percent)		No metal produced	23.0	44.0	68	89	93	95

* Probably per cent carbonaceous reducing agent, not per cent carbon.

TABLE X. Selective Carbon Reduction of Iron

Per cent coke charged		6.0	6.5	7.2	23 (excess)
Time of smelt — hours		2.5	2.0	3.5	3.0
Kw.-hr. consumed		225	185	262.0	225–2.96 kw.-hr. per lb. alloy
Per cent. analysis ferroalloy	C	3.10	2.38	....	6+
	Cr	28.5	20.0	39.2	54.8
	Fe	67.5	75.0	53.1	33.3
	Si	.....	0.43	....	....
Per cent yield		15	21.5	44.0	....
Iron in alloy		27	44.0*	67.0	....
Per cent yield		4.0	3.4	18	95.0
Chromium in alloy		9.0	7.0*	25	(slag clean)
Weight charged (lb.)		200 Low silica	225 Higher silica	260	170

* The slag contains 92 per cent of the chromium charged

TABLE XI. Decarburization of Metals

Test No.	Charge, Grams Ferro-chrome	MnO_2	Picotite Conc.	Crucible Material	Decarburized Metal % C	% Cr	% Fe	% Mn
1	500	50	...	MgO	6.27	.....	.....	.....
2	200	50	...	MgO	1.45	47.98	37.2	7.8
3	280	20	75	Picotite	1.58	51.16	43.56	0.45
4	500	20	125	Picotite	3.73	52.58	43.00	0.16
5	500	150	...	Picotite	3.24	52.58	36.56	3.65
Second decarburization of metals from tests Nos. 4 and 5								
6	363(#4)	100	...	Picotite	0.41	36.50	56.68	4.31
7	200(#5)	50	...	MgO	0.85	45.04	44.24	5.33

TABLE XII. Analyses of Chromite Refractories

Analysis Per Cent	Domestic Chromite Concentrates	Standard Chrome Brick* No. 1	No. 2	No. 3
Cr_2O_3	44.6 to 41	36.7	30.1	35.5
FeO	23.6 to 19.6	14.2	12.0	13.2
SiO_2	0.8 to 5.7	7.5	5.1	6.7
Al_2O_3	16.8 to 16.5	21.4	17.5	22.9
MgO	12.4 to 15.1	19.3	32.2	21.6
CaO	0.08 to 1.2	0.4	Trace	Trace
MnO	0.84	....	....	....
Ratios Cr_2O_3 to:				
FeO	1.9	2.6	2.5	2.7
Al_2O_3	2.7	1.7	1.8	1.5
MgO	3.6	2.0	0.9	1.6

* Data from Basic Refractories — 1939 Catalog, and Boulder analysis of the standard refractories in use in the pilot furnaces.

method of ferrochromium smelting is carried out in open-top, stationary short-shaft, one- or three-phase electric furnaces. Electrodes are of the "Solderberg" or continuous baking type. The charge is mixed dry and fed into the top of the shaft around the electrodes. The molten ferroalloy and slag are tapped into cast-steel pots, and separated when cold. The carbon content of the product is controlled (3-10 per cent C) by varying the amount of carbonaceous reducing agent on the charge.

Power consumptions and chromium recoveries on high-carbon as compared to medium-carbon ferrochrome are given in Table I. These recoveries are based on the production of a 65-per cent chromium ferroalloy. The comparative prices of high- and low-carbon alloys in July, 1934 are given in Table II.

Gravity Concentration of High-Iron Montana Chromites. (1) Diaphragm Jig Concentration: Minus 20-mesh unsized, unclassified ore was concentrated with the results given in Table III. (2) Pilot Plant Table Concentration: Results are given in Tables IV and V.

It is evident that regardless of the Cr/Fe ratio in the heads the ratio of chromium to iron in the concentrates is approximately 1.7.

The recoveries in the pilot-mill runs were above 90 per cent.

The term "fines" in Tables IV and V is used to designate sample rejects received from the Reno Station which were found to contain 51 per cent —20 mesh. Approximately 15,000 lb. of these concentrates was produced for subsequent electrothermal investigations.

Electric Furnace Smelting of Montana Chromium Ores. (1) Direct, no fluxes: Several 200-lb. charges of Montana chromite mine-run ore were smelted in an electric furnace. The reducing agent used was petroleum coke from a California oil refinery and of the following composition: fixed carbon, 87.8 per cent; volatile, 11.9; benzol soluble, 1.2; sulphur, 1.2; ash, 0.3; H_2O, 1.9. The coke on the charge was 20 per cent. Ore and coke were crushed to minus ½-in. mixed thoroughly and briquetted. No fluxes were added. Charges were intermittent batch smelts, i.e., the furnace was at room temperature at the start of each run.

Electric Furnace Smelting of Montana Chromium Concentrates. Electric furnace smelting of these ores direct, without fluxes, produced waste slags containing only 3 per cent of the chromium charged. Table VIII gives the results of smelting the concentrates made from these ores in the gravity concentrating pilot plant.

In the gravity concentration, magnesia and silica are the principal gangue minerals removed. The concentrates produced then require 13 per cent of their weight of silica, to be added as a flux in smelting. Hence, the rejection of magnesia is the principal advantage gained by gravity concentration other than the gain in tenor of chromium.

Microscopic examination of the concentrate by Cooke[3] showed the presence of quantities of chlorite, serpentine, magnesite, and siderite, both locked and free. Examination of a polished section showed that the chromite was not zoned and that no free magnetite was present.

"By crushing through 150-mesh and carefully vanning the — 150 + 200-

mesh material, a good separation was effected between the chromite and the gangue minerals. This cleaned chromite was identified petrographically as picotite $(MgFe)O(Al,Cr)_2O_3$."

This carefully cleaned sample represents the pure chrome mineral and is the best product that can be obtained by ore-dressing methods. The chrome-iron ratio in the picotite is about 1.7.

Bessemerizing of High-Iron Ferrochrome. The chromite-lined electric furnace hearth used is mounted on rollers and can be tilted forward or backward, which allows blowing various mixtures of air, oxygen and fluxes through the oil-cooled tuyere and into the molten chromium-iron metal. Electrothermal energy can be applied while blowing.

Preliminary Bessemer trials on 150 to 200 lb. of molten ferrochrome baths, in contact with high-silica slags, were made with oxygen and with air-oxygen mixtures.

Bessemerizing of high-iron ferrochrome oxidizes the chromium more rapidly than either the carbon or the iron. However, the oxidation is too slow to justify further investigation.

Selective Carbon Reduction of Iron in Chromite. Bogitch[4] gives data (Table IX) on the ferroalloys produced by varying the carbon on the charge. The analysis of high-grade chromium mineral used was: Cr_2O_3, 51.2; FeO, 16.5; MgO, 13.4; SiO_2, 3.5; Al_2O_3, 14.9.

Selective Carbon Reduction of Iron in Domestic Chromite. The selective reduction of iron from Montana chromium concentrates has been demonstrated in the pilot electric furnace.

Analysis of the slag or beneficiated chromite from which the excess iron has been removed is, on 3-12-40: Cr, 27.5 per cent; Fe, 10.2 per cent. The ratio of chromium to iron is 2.7. This slag when poured to the second pilot furnace—temperature 1650 to 1700 deg. C.—is reduced by petroleum coke to a standard ferrochromium alloy.

Decarburization of Domestic High-Iron Ferrochromium. Slag Resistance Furnaces. Bogitch shows as low as 0.3 per cent carbon in the high-iron alloy selectivity reduced from a high-grade chromite smelt. The furnace used by Bogitch was a direct-arc type with automatic voltage electrode control. The electrodes were not in contact with the bath.

The pilot smelting furnaces in the Boulder laboratory are of the submerged-electrode slag-resistance type, and the lowest carbon made was 2.38 per cent in the chromium alloy produced in selectively reducing the iron. This alloy analyzed 20 per cent Cr, 75 per cent Fe, and 0.43 per cent Si. When automatic voltage-control electrode equipment is available, comparative smelts are anticipated.

Induction Furnace Decarburization. Crucibles were made in the laboratory of domestic chromite concentrates and commercial magnesia. These were pressed under 10,000 lb. per sq. in. pressure, dried and fired in place in the induction furnace. They served satisfactorily at temperatures of 1700 deg. C. in these small scale investigations.

High iron-chromium alloy used for tests 1, 2, 3, 4 and 5 (Table XI) contained 54.56 per cent Cr, 34.16 Fe, 6.62 C, and 0.08 Mn.

The metal was held in the molten state approximately one hour in contact with the decarburizer. The induction furnace power supply was held at 15 to 17 kw.

Use of high-iron chromite for decarburization of high-iron high-carbon ferrochrome is questionable because of the ease of reduction of the iron from the high-iron chromite concentrates and consequent dilution of the chromium alloy. These decarburization data are to be considered as only indicative because of the small surface contact between the oxidizing slag and the alloy, and because the slag is always at a lower temperature than the alloy. Proper mixing of the two is not effected under these induction furnace conditions. The larger scale decarburization investigations are planned to be carried out in a standard direct-arc furnace with several types of decarburizing slags.

Montana Chromite Concentrates as Metallurgical Refractories. Table XII gives the comparative analysis of several standard chromite refractories used in steel and copper furnaces.

The crucibles and furnace linings of domestic chrome concentrates can be made to withstand temperatures and corrosive slagging action as well as the standard products in laboratory use.

According to Seil:[5] "For refractory purposes, the percentage Cr_2O_3 in itself is not a decisive factor, and ores relatively low in chrome-oxide content are used if the percentage Al_2O_3 is relatively high."

"According to at least one authority,[6] the most satisfactory all-around mixture is 75-per cent chrome ore and 25-per cent dead-burned magnesia."

Summary of Conclusions

1. Domestic high-iron chromite concentrates, when smelted and reduced with petroleum coke in the Boulder laboratory electric-pilot furnaces with 93 to 95 per cent recovery of the chromium, require 2.9 kw.hr. per pound of ferroalloy. The analysis of the product is 54.3 per cent chromium, 33.3 per cent iron and 6.0+ per cent carbon.

2. Forty per cent of the iron containing only 8 to 10 per cent of the chromium, in the high-iron chromite charge, can be selectively reduced and separated from the chromium. This 20 per cent chromium-75 per cent iron-2+ per cent carbon alloy is of value in the production of heat-resistant castings.

3. An industrial-size electric furnace for the production of standard ferrochrome from high-iron domestic chromites would be built so that the high iron-chromium alloy could be tapped off the bottom; the molten chromium enriched slag would then be reduced to standard ferrochrome without transfer and consequent loss of thermal energy. The standard direct-arc type steel furnace is recommended for this operation.

4. Basic refractories of the chrome-magnesite type can be made from the domestic concentrates which compare favorably with the present commercial basic refractories.

5. Further work is justified on various slag constituents and systems and their effect on the reduction of the beneficiated chromium product and on the decarburization of the standard ferrochrome.

[3] Koster, J., Shelton, S. M., Knickerbocker, R. G. Report of Investigations 3322, Bureau of Mines, October, 1936.

[4] Bogitch, M. B. "On the Preparation of Ferrochrome in the Electric Furnace." Academie des Sciences, Comptes Rendus, Vol. 197, No. 2 (Oct.-Dec.) 1933.

[5] Seil, G. E., Work cited (footnote 1).

[6] Nonmetallic Mineral Industry, Bureau of Mines, I. C. 7106, p. 8.

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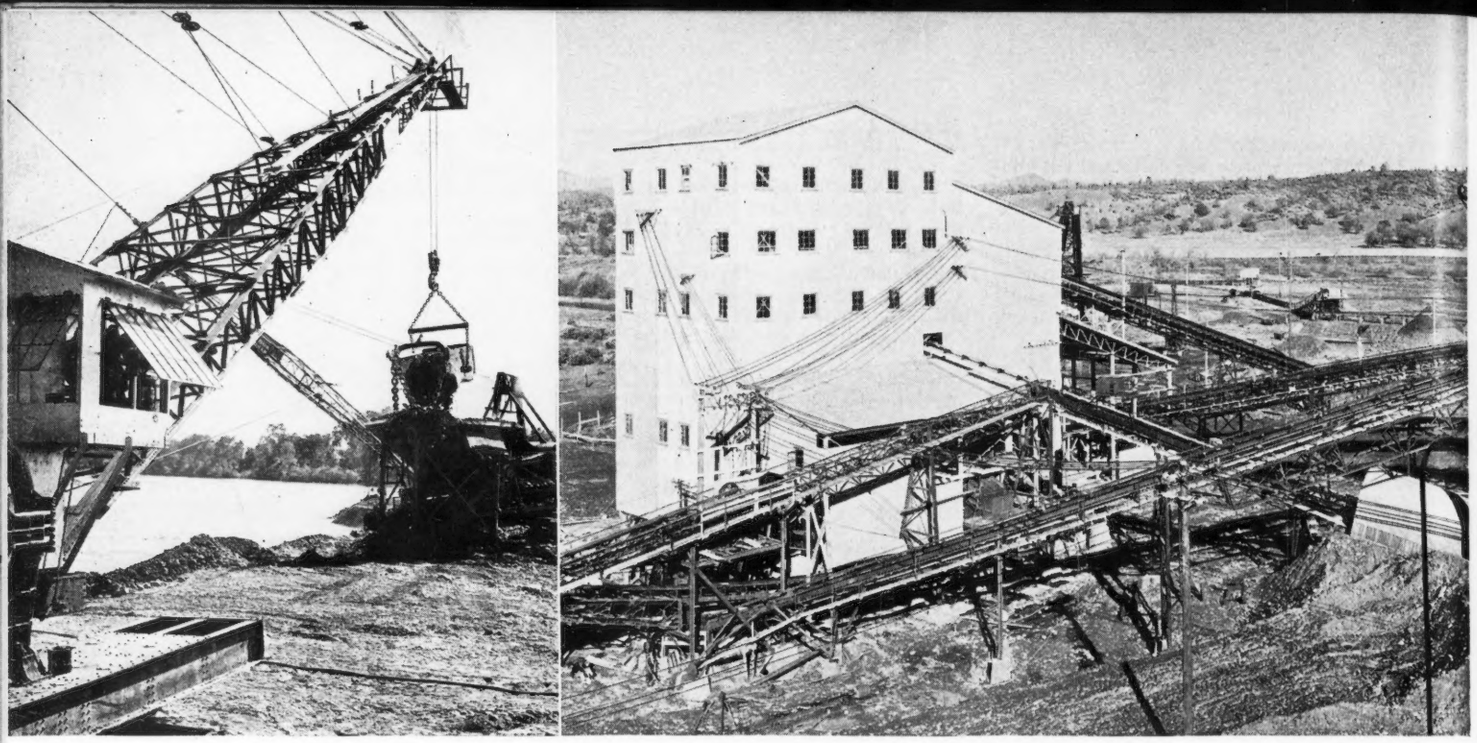
The Story of Alloy Steels

THE STORY of alloy steels is told in a sound motion picture film recently produced by the Bureau of Mines in cooperation with an industrial concern. Various scenes portray "milestones" in the history of this development. In 1742 Benjamin Huntsman produced the most reliable and uniform steel known in his day. In 1868 Robert Mushet added manganese and tungsten to high-carbon steel and found that the resulting alloy would harden when cooled normally in air, thus originating the first self-hardening tool steel. In 1890 an improved method of heat-treatment made possible the development of cutting tools that ran at 100 to 150 f.p.m. Within a few years, many brands of high-speed steels were on the market. During this period Julius Baur's chromium steel process was patented, Sir Robert Hadfield perfected a high-manganese steel bearing his name, and French metallurgists first alloyed steel with nickel. Molybdenum, then vanadium, entered.

Between 1900 and 1906 several brands of English and American high-speed steel of the same chemical composition as the modern 18-4-1 steel appeared. Advent of the automobile created need for stronger, more reliable steel, and in 1912 the SAE numbering system for carbon and alloy steels was established.

In 1917 the molybdenum deposit at Bartlett Mountain, Climax, Colo., became the source of supply for British and American steel makers. In 1918 metallurgists developed the chromium-molybdenum series. In 1919 chrome-silicon steels were introduced, followed in 1921 by chrome-nickel-molybdenum steel; in 1922, by nickel-molybdenum steel; and in 1926, by manganese-molybdenum steel. In 1930 molybdenum again took its place in the manufacture of high-speed cutting tools. Small percentages of tungsten were combined with molybdenum and the resulting steels were standardized.



One of two Bucyrus-Monighan draglines excavating material from the Sacramento River bed at Redding, Calif. The six-story washing plant will clean about 10,000,000 tons of sand and gravel to be placed in Shasta Dam. Equipment to recover any gold in this gravel is also housed in this plant. Tailings are conveyed nearly ten miles to the dam site

Placer Mining

World's longest conveyor system

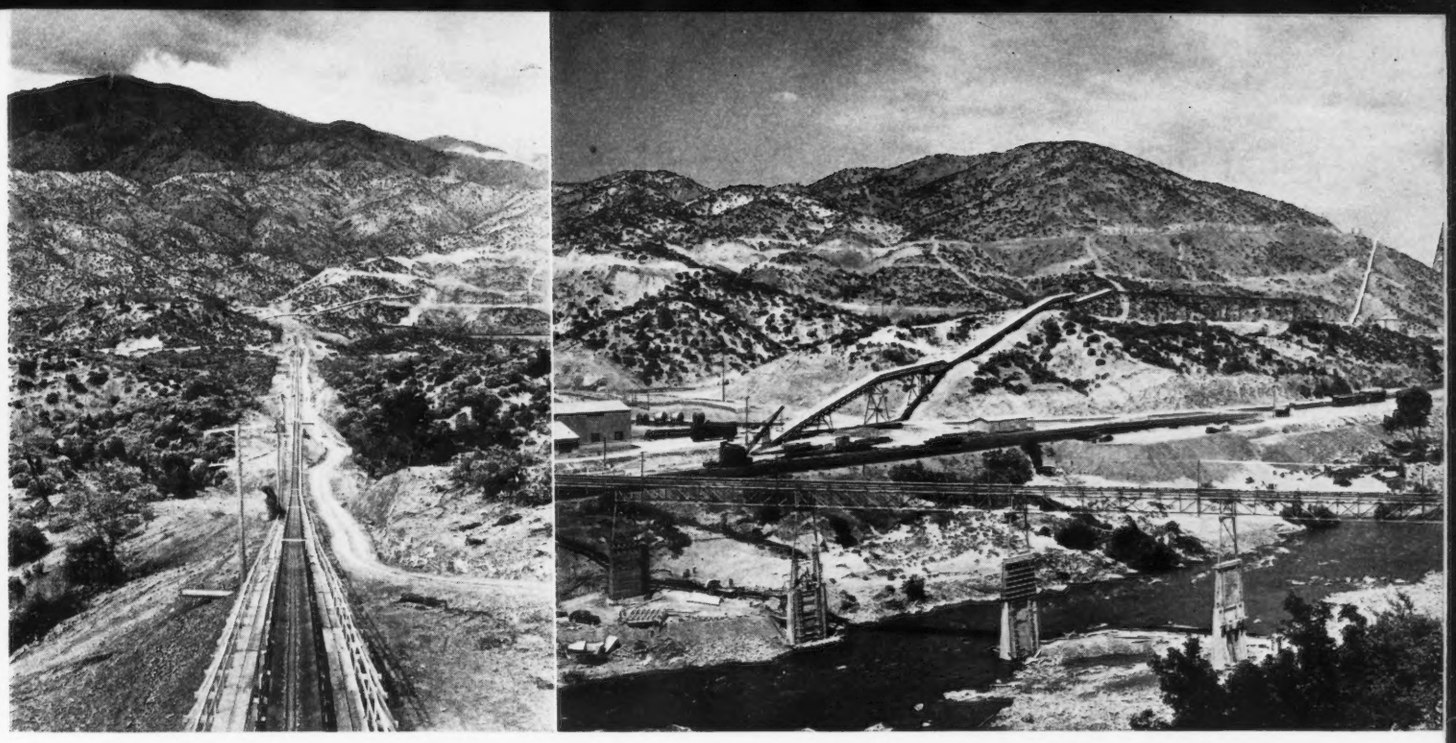
RECOVERY of placer gold in the process of washing gravel for the construction of Shasta Dam, in California, adds a highlight to a material-handling operation that would be unique even without that feature. The longest belt conveyor in the world, 9.6 miles, will transport sand and gravel over hill and valley from source to point of use. The entire project is under the direction of the United States Bureau of Reclamation, and is designed to control flood waters of the Sacramento River, divert water for irrigation, and provide a source of hydro-electric energy. The dam is expected to be completed in 1944.

At the initial placer mining operation at Redding, Shasta County, gravel is removed from the Sacramento River bed by two Bucyrus-Erie Monighan draglines, one electric and the other diesel-powered, with 175-ft. and 140-ft. booms, and 10-cu.yd. and 8-cu.yd. buckets, respectively. Delivery is made to a series of three 42-in. pendulum belt conveyors with capacity of 1,250 tons per hour, that supply a large jaw crusher set at 6-in. preceded by a Tyler Ty-Rock vibrating screen with 6½-in. openings. The crusher product and screen undersize go to a raw storage pile. Successive lifting by belt conveyors brings the material to the gravel preparation plant in which equipment for removing the gold is located.

The gold-recovery plant, now in the first stages of operation, is installed between two 8x11 slug mills and two Dorr hydro separators. Feed is obtained from an Allis-Chalmers 8x11-ft. slug mill, overflow going to eight two-cell primary Pan-American jigs from which the hutch product goes successively into a small sand drag, two Pan-American pulsator jigs, and a Titan rotary amalgamator. Tailings from the amalgamator go to two small pulsator jigs from which the concentrates are returned to the cleaner jig.

Finished products from the washing plant pass over Merrick weightometers to stockpiles of coarse, medium, and fine sand. These grades of sand are hydraulicly separated and vary from No. 4 to 200-screen size. Conveyor belts in the reclaiming tunnels convey these materials to a blended sand stockpile that feeds the 9.6-mile conveyor system transporting material to the hopper at Coram, which is at the dam site. The four stockpiles of coarse aggregate are respectively sized from 6 to 3 in., 3 to 1½ in., 1½ to ¾ in. and ¾ to ¼ in. The fine sand is first fed to the belt, serving as a cushion for the aggregate which follows.

There are 26 separate conveyor sections in the system, ranging in length from 900 to 3,400 ft. center to center. The longest single unit conveyor belt in the world is at the Grand Coulee dam, being about a mile long, and the second longest is at the Shasta dam project. The belt is 36 in. wide, of six-ply duck with a 3/16-in. rubber cover on top and 1/16-in. rubber cover on the under side, made by Goodyear Tire & Rubber Company. A total of 20.4 miles of belting is used in the 26 sections. The volume of rubber required was 700,000 lb., and 500,000 lb. of cotton was used. The Chain Belt Company supplied the 50,500 malleable castings and 16,000 troughing idlers



Although a railroad virtually connects the gravel pit with the dam site, estimates showed a material saving by using a long conveyor system. On the right the general view looks obliquely upstream showing second river crossing of conveyor and covered portion leading from the Coram terminal to storage and then to the dam

for Shasta Dam

will carry gravel washed for gold

and rollers that run on 83,000 Timken tapered roller bearings. Fifteen tons of grease were required for the first lubrication of the complete system.

Operations begin at an elevation of 497 ft. above sea level, rise to 1,350 ft., and drop to the unloading point at 652 ft. above sea level. General Electric motors supply the 4,200 hp. necessary to move the material to the highest point. Power is furnished by a 200-hp. motor at the head pulley of each section, and controls for each motor are so interconnected that stoppage of any belt section automatically shuts down all others between it and the gravel pit. On the downgrade sections a total of 460 hp. is generated, which is fed back into the power line. In the event of power failure while the downgrade units are loaded, an automatic brake clamps the tail pulley and stops the line until electric power is available again. The 26 transfer stations house the motors for each belt section, and each station is connected by a telephone line that can be cut into a 50-watt radio transmitter at the crest of the hill on the belt route. The radio provides two-way telephone communication with sets in 1½-ton trucks used by the patrolmen. Transmitters in the trucks are of 15-watt power; wave bands 31,000 and 39,000 kilocycles. Patrolmen at work on the belt can leave the loud speakers switched on and thus be called to the telephone if within hearing.

Steel chutes are provided at each belt discharge. One, short and steep, serves while the belt is starting up or slowing down, during which time the material otherwise would fall, tending to break up large-sized rock and thus destroy the accurate size proportioning. The second chute is set at a flatter angle to prevent spillage or breakage of large-size aggregate at full belt speed. Wide rubber tires under the belt serve to cushion the fall of the gravel. A pipe line along the conveyor provides water at all transfer stations to keep the belt clean. Lighting is by incandescent lamps.

Various devices are used to prevent the belt, when running empty, from riding up out of the trough made by the roller guides. Shims placed under the roller supports so as to give a forward tilt to the inclined rollers aid in training the belt. Special training rollers of two types are also used, each with its roller frame free to swing around a king pin. In one of these, the roller projects above the belt level at the outer edge of the trough. Should the belt edge slip to one side far enough to contact one of these rollers, the reaction is to press a brake against the inclined roller on this side. This increased friction tends to rotate the roller frame and thus forces the belt back into the trough. The other type is designed to accomplish the same purpose by frictional resistance set up in a heavy unbalanced roller paralleling and just outside the inclined roller where it comes into action if the belt slips over the edge. The speed of the belt is 550 f.p.m., calculated for delivery of 1,100 tons per hour, or 22,000 tons per day of twenty hours.

Photographs shown above were taken by B. D. Glaha, and released through the courtesy of United States Bureau of Reclamation.

Some Economic Aspects of Philippine Manganese

Output this year will exceed 50,000 tons. Ore reported to be of good average grade, contrary to widely held ideas. American buyers now have edge on Japanese

W. F. Boericke
Manila, P. I.

VIRTUALLY UNKNOWN as a source of manganese ore prior to 1936, the Philippine Islands exported approximately 50,000 tons in 1938, and despite a poor start in 1939, due to falling prices and lack of sustained demand up to the outbreak of the war, shipments were about 36,000 tons, with much more ore produced but held in stockpiles. In the opinion of well-informed engineers, the 1940 production will exceed 50,000 tons and may reach 70,000 tons, depending on the continuance of the present demand at substantially higher prices than prevailed in 1939, as well as on obtaining cargo space for shipment abroad.

The accompanying table, obtained from data released by the Philippine Bureau of Customs, shows the sharp increase in tonnage and value of the manganese ore shipments from the Islands since 1935.

Philippine Manganese Shipments Reported by Bureau of Commerce

Year	Metric Tons	Value, Pesos	Average Value, per metric ton
1935	519.310	13,213	25.40
1936	254.972	6,020	23.60
1937	12,206.278	337,716	27.80
1938	49,359.149	998,907	20.00
1939	35,998.075	766,899	21.25

A widespread misconception unfortunately exists that Philippine manganese deposits are of low grade. This is not generally true. The *Minerals Yearbook,* 1939, of the United States Bureau of Mines lists Philippine ore as averaging between 45 and 50 per cent Mn. This compares with a 38 to 50 per cent grade for Brazil, 47 to 52 per cent for India, 41 to 48 per cent for Russia, and 30 to 51 per cent for South Africa, the principal producing countries. The accompanying table indicates that the average price received by Philippine producers during 1938-39 was about 20.60 pesos per ton. (The Philippine peso is equal to 50c. U. S. currency.) Inasmuch as a base price of 20 to 22 pesos for 50 per cent ore f.o.b. Philippine ports has been the scale during most of this time, it follows that the grade of ore shipped must have averaged close to this figure, and this is confirmed by inquiry from buyers. Indeed, it can be said that at present in the Philippines ore below 48 per cent has a hard time finding an export market.

It is true, however, that there is much ore in which the manganese content, although averaging well over 40 per cent, contains so much silica that it cannot meet requirements. Occasionally the phosphorus exceeds the limit of 0.12 per cent. Much Philippine manganese ore is hygroscopic, and the moisture may average 10 per cent and even be higher. Of course, this adds substantially to ocean freight charges.

To date no large well-defined manganese orebodies have been found in the Philippines of a size and importance comparable with those of the major producing countries. There is no dearth of small deposits; in fact, manganese is found on every large island, and on many of the smaller ones, but in nearly every instance the deposits are of limited extent and occur more as enriched pockets or lenses than as commercially important orebodies. To evaluate a mining claim containing such occurrences, exposed as they usually are by a few shallow shafts, open cuts, or trenches, is impossible except as an approximation, which must be based on the geology and the characteristics of similar lenses in the same area.

This is not to say that no large manganese deposits will be found. Such an assertion would be unwarranted by the limited prospecting done to date and the large areas that are virtually unknown. Little well-planned, scientifically-directed, or properly-financed work has been done on manganese. Mining activity in the Philippines has been devoted principally to gold, with iron, copper, manganese, and chrome taking a subordinate place. The total value of base metals produced in 1939 was 15 per cent of that of the gold. Although a large number of so-called manganese mining companies were promoted during the stock boom of 1935-36, few were headed by men who had any practical knowledge of manganese mining, and little was done for the money spent.

Until recently, lack of an active market for manganese ore has dampened investor's interest in new developments. Up to the start of the war practically all Philippine manganese was bought by Japan. The financial difficulties of that country have made foreign exchange hard to obtain and scarcity of freighters has not helped. When hostilities broke out in Europe, the local manganese market improved, and with the establishing of the fund for purchase of strategic minerals by the Procurement Division of the United States Treasury American buyers really came into the market. Since then most of the Philippine manganese has gone to the United States, and some interesting contracts have been placed.

The producer's ignorance of the requirements of ore buyers in the United States has often resulted in dissatisfaction with trial shipments that have failed to come up to grade. Stipulations regarding allowable percentages of iron, silica, and phosphorus have not been understood or have been lightly disregarded, and little attention has been given to ore sizing or moisture. On the other hand, American buyers have done little to make it clear what ore would be acceptable and what would be penalized. Occasionally things work out all right, however. The president of a small company told me that in sheer desperation he cabled an ore buyer listed in the *E.&M.J.,* asking if he would accept a 500-ton lot, with assay, price, and final settlement to be made on the buyer's sole determination. This extraordinary offer was accepted, the shipment made, and the Philippine producer received a check in settlement that he regarded as entirely fair.

Until recently the Japanese ore

buyer had the distinct advantage of being able to quote a relatively higher price on manganese ore than the American buyer on account of the differential in freight rates. Before the outbreak of the war, manganese ore was quoted about 30c. a unit c.i.f. Atlantic ports. This is equivalent to 30 pesos per ton for 50 per cent ore. Freight to New York before the advance due to war conditions was about 14 pesos per ton, to which was added insurance and handling charges. This left about 15 pesos net to the producer. At that time Japanese buyers quoted 20 pesos per ton f.o.b. Manila or Cebu, so the ore went to them.

At present, with the price in the United States 50c. a unit approximately, 50 per cent ore is worth 50 pesos per ton, and, although freight rates have been advanced to 19 pesos (with indications that they will go still higher), the net price by American buyers to Philippine producers favors the latter. Shortage of ocean bottoms to Japan is an additional handicap for their buyers.

Penalties on manganese ore with high silica, iron, and phosphorus were lighter under Japanese than American contracts. American ore buyers formerly set up limits of 6 per cent on silica, 4 per cent on iron, and 0.1 on phosphorus. The specifications of the Procurement Division of the Treasury allow 7 per cent on iron, 7 to 10 per cent on silica, and 0.12 to 0.18 phosphorus. Japanese buyers accepted ore right along with 8 per cent silica, 6 per cent iron, and 0.2 per cent phosphorus without penalty.

From a broad viewpoint the interest of the Japanese in Philippine manganese is easy to understand. The British Imperial Institute estimates that on account of the rapid growth of its iron and steel and chemical industries, Japan's manganese requirements have so increased that the country must import 200,000 tons annually to supplement domestic production. Although Japan has a not inconsiderable manganese production of its own, estimated at 50,000 to 60,000 tons annually, this is inadequate for industrial needs. Imports have been obtained from India, British Malaya, and French Indo-China, but only India has prime importance. Obviously, if a source of supply can be found nearer to Kobe and Yokohama, it would benefit Japanese blast furnaces. Philippine manganese miners must contend with the following difficulties in developing and mining their ore deposits:

1. The deposits are generally small, more or less disconnected and discontinuous lenses that do not permit large-scale mechanized development nor warrant large capital expenditure. Estimate of positive and probable ore is hazardous.

2. There is a lack of engineers experienced in manganese mining operations and particularly in manganese beneficiation.

3. Uncertainty of ore markets, obstacles in contacting foreign buyers, high lighterage charges, and difficulties in shipping during the typhoon season.

4. Occasional irritating and costly delays in obtaining leases or title to ground because of conflicting claims and litigation. Nuisance suits have been all too common and have tied up much promising territory.

5. Unfair and exorbitant royalties often asked by landowners amounting in cases to 20 to 25 per cent of the gross received.

On the other hand, the Philippine manganese miner has some real advantages:

1. Ore deposits that are generally easily mined without need for large expenditures for capital equipment. Only the simplest mining tools are require ordinarily. Much of the ore can

Sketch map of the Philippines showing Busuanga and Siquijor islands, where the principal manganese-producing areas are situated

Loading manganese ore on lighters at Bani, Camarines Sur

Mining manganese by open cut at Siquijor

be cleaned by primitive beneficiation methods and is generally of satisfactory commercial grade.

2. Cost of road construction to new deposits is not high and averages about 1,000 pesos per kilometer in most places. Trucking can be contracted at about the same cost as in the United States.

3. The wage scale is about one-tenth of that paid in the United States (75 centavos to 1 peso per day), with labor abundant and generally suitable for open-pit and surface mining. Much of the work can be contracted under the *paquaio* system, whereby an entire operation is contracted by a single family or local group of laborers working under their own boss.

4. As labor, aside from supervision, comprises at least 75 per cent of the cost of manganese mining, the operating cost is often low. Instances are known where the entire over-all cost, including trucking to point of shipment, has been from 7 to 10 pesos per ton of cleaned product.

The Philippine manganese industry has thus far attracted little American or European capital. Most of the mining is done by Filipino companies with native engineers in charge. The most extensive manganese deposit in the Islands, at Siquijor, however, has recently been taken over by an American company with an American engineering staff. The young Filipino mine superintendents are technically trained, hard working men, but often lack operating experience and too frequently are confronted with their employers' demands to forego capital expense to reduce costs or increase efficiency, and to make immediate profits. In consequence, development and prospecting for new orebodies are generally neglected, and there is scarcely a manganese mine that can point to any developed reserves. The result is that operations frequently cease while the management goes into a huddle to determine whether to look for new ore or call it a day. Under such conditions it is difficult to build up an efficient organization or to assure buyers of a continuous supply of ore of a determined grade. Several producers are now taking steps, however, to avoid in future this hand-to-mouth ore production, and a more stabilized output seems probable.

Manganese deposits are widely found in the Philippines, as noted. Production has come from Bani, in Camarines Sur; from the Siec deposits in Ilocos Norte, from the Guindulman deposit in Bohol, from Milagros in Masbate, and from the Mahinay deposit in Panay. But by far the principal tonnage exported has come from two small islands, Siquijor, south of Cebu, and Busuanga, one of the Palawan group, southwest of Mindoro. It is interesting to note that neither island contains commercial deposits of any other mineral except manganese. These islands are shown on the accompanying map.

The Siquijor manganese deposits have been mined intermittently for over three years. Production has come from several individual deposits, some of which have produced considerable ore. Total output has been approximately 40,000 tons, of about 43 to 46 per cent grade. The main orebody has been the so-called "Mine" deposit, where the ore is exposed along a steeply dipping fault fissure between conglomerate and lime. The orebody is about 450 ft. long on the surface, with width varying from 2½ to 8 ft. At the 50-ft. level it widens out to 27 ft. and has been mined by ordinary stoping methods for several hundred feet. The ore appears to be of hypogene origin, and could continue to greater depth. Crude ore as mined contains about 42 per cent Mn.

Ore bin and slides at Philippine-Nippon mine in Busuanga

About 8,000 to 10,000 tons of concentrates were obtained from the "Placer" deposit, which appears to be residual in character. The ore occurred as fine nodules of pyrolusite mixed with clay, along the top of a hill, covering an area about 425 by 170 ft., with an average thickness of 6 ft. The crude ore contained about 30 per cent Mn, and by simple washing with sea water in a sluice box the grade could be raised to 45 per cent, with about 54 per cent recovery. Additional ore was obtained from the "Flat Vein" deposit, 250 ft. long and about 4 ft. thick, which dipped into the hill at a low angle and was worked by open cut. About 8,000 tons of good-grade ore have been mined from Basac, where the manganese occurs as irregular lenses in soft decomposed limestone, as well as a considerable tonnage from Siquijor No. 2, where the manganese ore fills a steeply dipping fault fissure in limestone. This has been developed to a depth of 50 ft.

At present under the new management this property is being vigorously developed, with promising results, and it is reported that a substantial amount of new ore has been found. Estimates of probable ore made in 1938 varied from 40,000 to 200,000 tons, depending, it would seem, on the optimism of the examining engineer, as there was little ore "blocked out."

The new management has erected a 125-ton mill, the first manganese mill in the Philippines, and uses jigs. Results are said to be satisfactory, and a concentrate over 50 per Mn in grade is obtained, with a recovery of about 60 per cent.

In the opinion of the comparatively few engineers who have visited it, the island of Busuanga, about 35 hours distant from Manila to the southwest, contains the most promising manganese deposits in the Philippines discovered to date. The island is well off the beaten path of travel, with infrequent stops by trading steamers, and the climate is malarial. Living accommodations are none too good.

Four mining companies are operating in Busuanga, and shipping high-grade ore that meets metallurgical requirements. The grade is uniformly over 50 per cent Mn, and in the main consists of hard lump ore generally free from fines, with low silica and iron. The orebodies occur in lenses, some of which are of large size, both laterally and vertically.

John Payne, Jr., consulting geologist, has pointed out that the Busuanga deposits recall those of California. In his opinion the ores are plainly of hydrothermal origin. The country rock is predominantly quartzite. The manganese ore is associated with a reddish, cherty jasperoid. Intense metamorphism and pronounced folding of the formations are evident. The principal mines are owned by the Philippine-Nippon Mining Company (now taken over by an American company), the Amalgamated Minerals, Fernandez Hermanos, and Cia. Min. de Filipinas. The Philippine-Nippon Company has shipped over 9,800 tons up to August, 1939, of high-grade ore (Mn 54.7 per cent). Production has come from a series of open cuts on the manganese lenses, which appear to lie conformably with the slope of the hill, and extend over a wide area. Some tunnels have been driven into the hill which have exposed "blind" lenses, and considerable additional ore is indicated. The property is not mechanized, and all mining thus far has been done by hand.

Amalgamated Minerals has produced about 9,000 tons of 52 to 54 per cent Mn ore since August, 1938, with present production 500 to 600 tons per month. Mining is by conventional underground methods, and some of the

stopes are large. The ore as mined requires no beneficiation.

Cia. Min. de Filipinas has had a limited production from its mines near Coron, but is now developing the Borac property, on the east coast, where a large tonnage of ore is indicated.

Fernandez Hermanos controls the Busuanga Mining Company and the Palawan Mining Company in central Busuanga. Considerable development work has been done on its various holdings, and a sizable amount of high-grade ore is held in stockpiles.

On one of the claims a manganese vein 6 ft. wide has been exposed for 180 ft. along the strike, and crosscuts into the hill have apparently identified it so as to give 100 ft. of backs. Additional manganese outcrops can be observed on other claims.

Detailed descriptions of the various manganese deposits on other islands of the Philippines will appear in Mineral Resources of the Philippines, Part II, which is now in press, to be published by the Philippine Bureau of Mines.

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A Copper Mine's Wire Rope Practice

ALL-WIRE rope used in the mining department of a certain copper company, whose operations were noted recently, is regular lay. In sizes ½ in. and smaller, 6x19 plow-steel rope is used, and in ⅝-in. and ¾-in. diameters 6x19 special plow-steel slusher wire rope is employed.

Hoisting wire ropes are 1 in. to 1¼ in. diameter inclusive, and are of special 6x25 flattened strand construction with outside wires of regular plow-steel and inside wires of improved plow steel with hemp core. Hoisting ropes are inspected daily by the hoist engineer and monthly by the master mechanic, who makes a written report to the mine superintendent. On the incline shaft (74-deg. slope) the hoisting ropes are changed annually. The rope is supported in this shaft by wooden rope slides and the wear is fairly rapid. In the company's vertical shafts it has been the practice to change the hoisting ropes every two years.

Sizes below ½ in. are used for small tugger hoists servicing stopes and pulling tram cars under grizzlies. The half-inch size is used mainly for endless-rope tram-car pulling and about two years' use is obtained. The ⅝-in. and ¾-in. sizes are used for car dumping, pocket-door control, and slusher hoists. The variable length of haul and intermittent operation of these slushers is such that tonnage and life figures expressed in time are not of much significance.

Some Milling Problems at the Raub Australian Plant

II—Difficulties of sampling . . . Features of the metallurgy . . . Effect of the carbonaceous gangue

E. C. Bitzer[1] and C. B. Nines

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THE presence of a large proportion of free gold in the primary amalgamation tailings from the dump and from currently milled ore required a good sampling schedule. The fact also that the rate of recovery had to be known for four distinct divisions of the treatment procedure called for special care from the time the samples were cut until the final weighing in the assay office. The expenditure for automatic sampling equipment did not seem to be justified for this operation; moreover, automatic samplers would not have been applicable in many places because of lack of headroom. After several months of experimenting and taking comparative samples by hand, the routine was standardized as shown in Table V.

Preparation and Assay of Samples—All samples were delivered in closed containers to the assay office where they were prepared for assay in a room free of dust. Dry pulps were cut down to size in Jones splitters, one of which was reserved for high-grade material to minimize the possibility of salting. Wet pulps were cut down by means of a wet-pulp splitter that consisted of a truncated cone on to which was welded a cylindrical section. The cylinder was fitted with two ½-in. pipes that delivered equal splits. Two of these devices were in use as in the case of the Jones splitters, one for low-grade and one for high-grade material. All wet pulps were allowed to thicken as far as possible in the containers and excess water was decanted before splitting. This was found to be especially important in the case of pulps on which moisture determinations were to be made, because the thinner the pulp the greater is the error in weighing the dry solids.

Almost every sample of material presented a problem, either in the method of taking the sample, its preparation, or the assay of the final sample. Errors due to "salting" were the most common, and these occurred frequently despite precautions. The carbonaceous flotation concentrate which contained copper and arsenic presented an assaying problem which was finally solved by roasting the material before fusion. Assay of cyanide solutions gave the most trouble, and every method was tried, including an electrolytic procedure. The Chiddy method as commonly described would not work, because the lead sponge formed could not be collected without filtering and it would not cupel directly because of the large amount of base metals precipitated with the lead and gold. A modified method was developed in which a large amount of lead acetate (25 grams per ten assay tons of solution) was used. The sponge was formed with zinc dust, and after elimination of the excess zinc the material was collected by filtration and fused with a small amount of borax and soda ash before cupellation. The solutions were assayed by this method in parallel with all others and gave consistently higher results than any of them.

Metal Balance—The sampling of ore ahead of the stamp battery was not feasible and the grade of ore milled in each five-head of stamps was determined from amalgam clean-ups. Inasmuch as the tailings from the amalgamating tables were not sampled individually, this value was for gold recovered and not total heads. Recovery grade thus determined was not strictly accurate for a number of rea-

[1] Mr. Bitzer's present address is 1200 12th St. Golden, Colo. Part I of this article appeared in the June issue.

Table V—Sampling Schedule

Sample	Interval	Sampling Period	Remarks
Current amalgamation tailing	30 min	24 hr	Full cut of pulp stream
Dump tailings	Each truck	24 hr	
Flotation head	30 min	8 hr	Full cut of pulp stream
Flotation concentrate	30 min	8 hr	Full cut of pulp stream
Flotation tailing	30 min	8 hr	Full cut of pulp stream
Calcine	See text	One batch	
Cyanide tailing	One filter cycle	One batch	Cut from leaves in rotation and repulped in strong $KMnO_4$ solution.
Gold solution	Continuous	8 hr	
Barren solution	Continuous	8 hr	

Table VI—Metal Balance, Fine Gold

Stamp Battery

Primary Amalgamation

Tons Treated	Head, Oz.	Tails, Oz.	Recovery, Oz.	Recovery, %
25,249	9,817	2,191	7,626	77.6

Tailing Treatment

1. Secondary Amalgamation

			Recovery, Oz.		Recovery, %	
Tons Treated	Head, Oz.	Tails, Oz.	Theoretical	Actual	Theoretical	Actual
46,693	5,023	3,561	1,462	1,615	29.1	32.1

2. Flotation

			Concentrate	Recovery		Tons Concentrate
Tons Treated	Head, Oz.	Tails, Oz.	Oz.	Oz.	%	Produced
46,693	3,561	1,178	2,383	2,383	66.8	817

3. Cyanidation

			Recovery, Fine Oz.		Recovery, %	
Tons Treated	Head, Oz.	Tails, Oz. [a]	Theoretical	Actual	Theoretical	Actual [b]
651	2,483	226	2,257	2,022	91.5	90.0

[a] 19.0 oz. of this calculated as dissolved loss. [b] Bullion plus tailing basis.

sons but was close enough to serve as a guide in mining. The per cent recovery of the entire stamp battery was calculated each month on a bullion-plus-tails basis, and it was necessarily in error due to the variable amount of gold tied up in mortar boxes. There was a normal swing of about 5 per cent in primary amalgamation recovery for this reason.

The metal balance of the plant is given in Table VI and shows comparisons of theoretical and actual recoveries averaged for a period of six months. The methods used in calculating recoveries for the various sections of the treatment are obvious in most cases, but it should be noted that the recovery and concentration ratio in flotation is calculated from assays, because it was not possible to determine the tonnage of any of the products directly except the tonnage of heads. All calcine was weighed into the agitators, however, which gave a rough check on the calculated flotation concentrate tonnage, because the percentage roasting loss on the concentrate was checked daily when the plant sample was assayed.

This metal balance is better than it appears in the statement because of factors that do not appear in the accounting. The apparent overage in secondary amalgamation is due to a quantity of gold that had been removed from a dismantled ball-mill scoop and from the space between the trunnion and trunnion liner of the mill. This clean-up amounted to 170 fine ounces of gold, compared to the calculated overage of 153 oz., and most of this gold had been accumulated in

Comparison of Precipitation Calculations and Gold Recovered in Bullion

Period	Calculated, Fine Oz.	Bullion, Fine Oz.
546	338	327
547	338	357
548	316	337
549	299	246
550	404	429
551	319	326
	2,014	2,022

the year previous to the period covered by the metal statement.

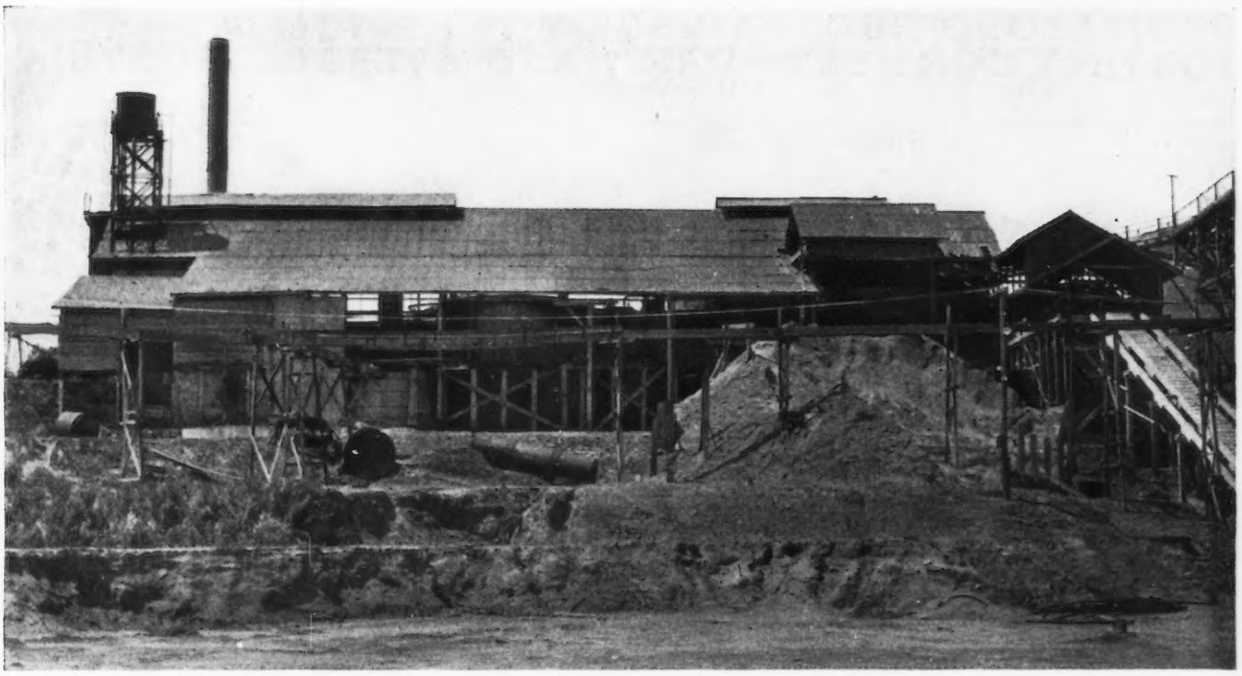
No reasonable explanation is found for the excess of gold in the calcine over that in the flotation concentrate, because normally there should be a shortage due to dust loss. However, the sum of gold recovered in bullion plus that in cyanide tailings is less than the amount calculated in concentrate; therefore the only conclusion that can be made is that the weighing and sampling of the calcine was in error in some way. The good check in recoveries of gold by secondary amalgamation, after allowing for the overage mentioned, seems to prove that the tonnage of original feed, as estimated from car factors, is close to actual, and an error in this estimate would be the most likely source of a discrepancy in the calculated concentrate tonnage.

Over-all recovery of the tailing treatment for the period covered by the metal balance is 72.4 per cent. Assuming that the rate of recovery on the current tailings is the same as that on the mixture of current and dump tailings, we find that the over-all recovery on ore as originally mined is at the rate of nearly 94 per cent. If no dump tailings were included in the tailing plant feed, it is likely that this figure would be slightly higher, because a higher flotation recovery could be expected from freshly mined ore.

Metallurgical Features; Laboratory and Plant Developments—The metallurgical procedure followed in treating this ore as described is not necessarily the only solution to the original problem, but most of the laboratory research was of necessity directed toward improving the performance of the existing equipment. This was unfortunate from the standpoint of pure metallurgical research, because the operation offered many opportunities for the study of problems of interest to gold metallurgists. The cyanidation of the calcine was a borderline operation because a small increase in the amount of copper in the material would have rendered the treatment uneconomical. It would be of interest to know more of the chemistry involved in cyaniding material of this nature as well as the reactions occurring in the precipitation and recovery of gold from the solutions, because instances of the treatment of this class of material are becoming more common.

The greatest loss of gold in this operation occurred in the flotation treatment, and most of the laboratory

Digging the canal to drain the tailings dump at Bukit Koman. The coolies are Chinese women



Raub tailings plant at Bukit Koman, seen from the dump. It was placed in operation in January, 1937. Ramp at extreme right leads to ball-mill storage bin. The flowsheet was presented and discussed in Part I, in the July issue

work was done on this problem. Microscopic examination of the tailings indicated that a small loss occurred from refractory sulphide particles that presumably were oxidized from long exposure in the tailing dumps. Screen analyses and assays indicated that the major part of the loss was due to the lock-up of gold in very fine particles of gangue or possibly from very fine, slime-coated gold. Either condition would make the material refractory to recovery by flotation. A long program of testing with various collectors and conditioning reagents showed that no combination of these held any promise of improving plant results beyond that of possibly paying for the additional cost of reagents.

The most interesting part of the metallurgy was developed in the plant. Over-all recovery was increased about 7 per cent by taking advantage of the tendency of the free gold to amalgamate in the grinding circuit. The possibility of controlling the gangue content of the flotation concentrate and the effect of this on cyaniding the calcine, although not worked out in practice, is of interest. The necessity for producing a high-grade bullion from a very base precipitate and the manner of accomplishing this should also be of interest to operators with a similar problem. The feature of this procedure was that the refining was accomplished with the usual melting equipment with the exception of a small pressure filter for dewatering the sludge from acid treatment of base bullion.

Effect of Carbonaceous Gangue—A certain amount of work was done to discover why the tailings from primary amalgamation were not amenable to direct cyanide treatment, because the elimination of the roasting operation would have been desirable. Recoveries of around 50 per cent were obtained by cyaniding carbonaceous dump tailings without regrinding. Similar tests on samples of flotation heads which contained freshly milled ore gave little or no recovery; hence, it seems that exposure on the dump had inhibited the effect of the carbonaceous material. A further proof of this was obtained by tests on fresh flotation concentrate. Samples of this material when cyanided in the mine laboratory were refractory, but a similar sample that was packed under water in a tight container and shipped to the United States for testing yielded about 50 per cent of its gold content by straight cyanidation.

Some tests were made to determine if gold was precipitated on the carbonaceous gangue during cyanide treatment. Carbon was floated away from pulps that had been cyanided for 48 hours and showed only a small gold content. Tailings from the tests assayed about the same as the heads. The gold found in the carbon concentrate was probably due to fine sulphides that had floated, and although the tests were not conclusive, the indication was that little if any gold had precipitated on the carbonaceous gangue. Carbon that occurs with ores is often overrated as a gold precipitant, and the effect in the case of this ore was probably that of causing a reducing condition in the pulp. Presumably, intense aeration would make cyanidation successful. However, it is unlikely that a straight cyanide treatment, assuming it to be feasible, would give as high a recovery or be performed as cheaply as the present treatment. If straight cyanidation were employed it would be necessary to concentrate the sulphides and give them a preferential treatment by very fine grinding to expose the gold. It is doubtful if fine grinding could accomplish this as efficiently as roasting.

▼ ▼ ▼

Wire Rope at a Zinc-Lead Mine

A CERTAIN zinc-lead mining company used preformed wire rope for a number of years on two shaft hoists and in one case where the fleet angle was bad obtained four times the life from preformed rope that was had with the conventional type. This rope was $\frac{7}{8}$ in. in diameter, 6x19 improved plow steel with hemp center. Depth of shaft 580 ft., and load hoisted was about 6,500 lb. at 600 ft. per minute. The company usually hoisted from 100 to 125 tons of zinc-lead ore in two 8-hr. shifts.in addition to considerable timber and from 30 to 50 tons of waste between different levels for filling.

In one shaft where water was present and where a faulty and damaged sheave caused excessive wear on the only preformed rope tried out, the company did not get exceptional life as measured in the first case; but the management states that even here, the longer life more than paid for the extra cost of the preformed rope.

MONTHLY COMMENT • DAILY AND AVERAGE MONTHLY

Summary of the

MARKETS

DEMAND for major non-ferrous metals was quite active early in June, inspired by unexpected purchases here for account of the allies and the huge rearmament program announced in Washington. But the collapse of France injected uncertainty into the minds of traders, chiefly those concerned with export business, and toward the close of the month renewed unsettlement disturbed the market.

The *E. & M. J.* index of metal prices for June was 78.85, against 77.68 in May, the moderate uplift resulting from higher monthly averages in copper, zinc, and tin.

Copper sales for domestic account totaled 111,860 tons for the month of June, which compares with 84,232 tons in May. During the first seventeen days the price was firm at 11½c., Valley, but subsequent uneasiness brought out business in the open market at 11c. and even at a shade under that level on June 27th. Excepting the United Kingdom and Japan, tonnage buyers in the export field virtually disappeared and export quotations were weak as the month ended. On the last day of June there were sellers at prices ranging from 10.70c. to 11c., f.a.s. New York, prompt shipment.

Lead sales were large, but again producers kept the price down to keep imports in check.

Prime Western zinc advanced to 6¼c., St. Louis. Allied business was a factor. Late in the month supplies were not so tight as earlier June.

Tin quotations moved over a wide range on nervousness in reference to developments in the Far East. Announcement that the R.F.C. agreed to finance a corporation to acquire 75,000 tons of tin in about one year at 50c. a pound, for stockpile purposes, caused general excitement in tin circles. Some believe that the action in effect will establish a minimum of 50c. on Straits tin.

UNITED STATES MARKET

1940	Electrolytic Copper Domestic (a) Refinery	Electrolytic Copper Export (b) Refinery	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
June						
1	11.275	11.325	54.750	5.00	4.85	6.00
3	11.275	11.400	55.000	5.00	4.85	6.00@6.25
4	11.275	11.425	54.750	5.00	4.85	6.25
5	11.275	11.375	54.250	5.00	4.85	6.25
6	11.275	11.375	53.750	5.00	4.85	6.25
7	11.275	11.425	54.375	5.00	4.85	6.25
8	11.275	11.425	54.500	5.00	4.85	6.25
10	11.275	11.350	55.000	5.00	4.85	6.25
11	11.275	11.425	56.500	5.00	4.85	6.25
12	11.275	11.425	57.000	5.00	4.85	6.25
13	11.275	11.425	58.000	5.00	4.85	6.25
14	11.275	11.400	58.000	5.00	4.85	6.25
15	11.275	11.400	57.250	5.00	4.85	6.25
17	11.275	11.425	56.250	5.00	4.85	6.25
18	11.025@11.275	11.325	52.125	5.00	4.85	6.25
19	11.025@11.275	11.200	53.250	5.00	4.85	6.25
20	10.900@11.025	11.100	54.750	5.00	4.85	6.25
21	10.900@11.025	11.050	55.000	5.00	4.85	6.25
22	10.900@11.025	11.050	54.500	5.00	4.85	6.25
24	10.900@11.025	10.950	53.750	5.00	4.85	6.25
25	10.900	10.950	52.250	5.00	4.85	6.25
26	10.775@10.900	10.925	52.250	5.00	4.85	6.25
27	10.775	10.775	53.000	5.00	4.85	6.25
28	10.775@10.900	10.750	52.500	5.00	4.85	6.25
29	10.775@10.900	10.725	52.700	5.00	4.85	6.25
			AVERAGES FOR MONTH			
June	11.128	11.216	54.618	5.000	4.850	6.235
June			AVERAGES FOR WEEK			
5	11.275	11.358	54.750	5.000	4.850	6.125
12	11.275	11.404	55.188	5.000	4.850	6.250
19	11.233	11.363	55.813	5.000	4.850	6.250
26	10.931	11.004	53.750	5.000	4.850	6.250
June			CALENDAR WEEK AVERAGES			
1	11.205	11.296	53.925	5.000	4.850	6.000
8	11.275	11.404	54.438	5.000	4.850	6.229
15	11.275	11.404	56.958	5.000	4.850	6.250
22	11.077	11.192	54.313	5.000	4.850	6.250
29	10.858	10.846	52.742	5.000	4.850	6.250

SILVER, GOLD AND STERLING EXCHANGE

1940	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
June						
1	320.5000	317.0000	(e)	(e)	(e)	$35.00
3	319.5000	316.0000	35.2500	23.5000	168s	35.00
4	318.0000	314.5000	34.7500	23.0000	168s	35.00
5	318.0000	314.2500	34.7500	22.7500	168s	35.00
6	318.0000	314.5000	34.7500	23.3750	168s	35.00
7	365.0000	(f)	34.7500	23.3750	168s	35.00
8	375.0000	371.5000	(e)	(e)	(e)	35.00
10	367.0000	363.0000	34.7500	23.0000	168s	35.00
11	378.0000	372.0000	35.0000	23.0000	168s	35.00
12	373.0000	(f)	35.0000	23.5000	168s	35.00
13	373.0000	367.0000	35.0000	23.3750	168s	35.00
14	369.0000	363.0000	35.0000	23.4375	168s	35.00
15	365.0000	(f)	(e)	(e)	(e)	35.00
17	361.0000	356.5000	34.750	23.0000	168s	35.00
18	362.0000	(f)	34.750	23.2500	168s	35.00
19	356.0000	353.0000	34.750	23.1250	168s	35.00
20	354.0000	(f)	34.750	22.8125	168s	35.00
21	355.0000	(f)	34.750	22.4375	168s	35.00
22	373.0000	(f)	(e)	(e)	(e)	35.00
24	370.0000	(f)	34.750	21.1250	168s	35.00
25	369.0000	(f)	34.750	21.1250	168s	35.00
26	372.0000	(f)	34.750	21.2500	168s	35.00
27	388.0000	(f)	34.750	21.6875	168s	35.00
28	391.5000	(f)	34.750	21.6250	168s	35.00
29	378.5000	(f)	(e)	(e)	(e)	35.00
			AVERAGES FOR MONTH			
June	359.560	.....	34.825	22.688	.....	35.00
			AVERAGES FOR WEEK			
June						
5	318.800	.....	34.969	.....	.....	.....
12	362.667	.....	34.850	.....	.....	.....
19	364.333	.....	34.850	.....	.....	.....
26	365.500	.....	34.750	.....	.....	.....

Calendar week averages, New York Silver: 1st, 35.438; 8th, 34.850; 15th, 34.950; 22nd, 34.750; 29th, 34.750.

(e) Not quoted (Saturday). (f) No quotations.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotation deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout June.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1940 June	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
3	Not quoted			276.5000	274.2500	Not quoted							
4	"	"	"	277.0000	274.7500	"	"	"	"	"	"	"	"
5	"	"	"	275.5000	273.5000	"	"	"	"	"	"	"	"
6	"	"	"	274.5000	272.5000	"	"	"	"	"	"	"	"
7	"	"	"	277.0000	275.2500	"	"	"	"	"	"	"	"
10	"	"	"	278.7500	277.7500	"	"	"	"	"	"	"	"
11	"	"	"	284.7500	284.5000	"	"	"	"	"	"	"	"
12	"	"	"	286.0000	285.7500	"	"	"	"	"	"	"	"
13	"	"	"	288.7500	289.7500	"	"	"	"	"	"	"	"
14	"	"	"	290.2500	291.5000	"	"	"	"	"	"	"	"
17	"	"	"	285.5000	286.5000	"	"	"	"	"	"	"	"
18	"	"	"	264.0000	265.5000	"	"	"	"	"	"	"	"
19	"	"	"	266.5000	268.7500	"	"	"	"	"	"	"	"
20	"	"	"	272.0000	275.0000	"	"	"	"	"	"	"	"
21	"	"	"	274.2500	278.0000	"	"	"	"	"	"	"	"
24	"	"	"	266.0000	269.2500	"	"	"	"	"	"	"	"
25	"	"	"	261.5000	265.5000	"	"	"	"	"	"	"	"
26	"	"	"	256.0000	258.7500	"	"	"	"	"	"	"	"
27	"	"	"	257.0000	260.5000	"	"	"	"	"	"	"	"
28	"	"	"	257.0000	259.2500	"	"	"	"	"	"	"	"
Average for month				273.438									

Prices for tin are the official prices of the London Metal Exchange, in long tons (2240 lb.). Trading in other metals remained suspended.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(July, 1, 1940)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	19c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	80c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$38.00
Quicksilver, flask of 76 lb., 100 flasks or more	$198.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	$30.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$57.34
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 53c.
50 @ 52 per cent	(b) 53c.
46 @ 48 per cent	(b) 48@50c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$23.50
Domestic, 65 per cent and upward	(a)$22.00@$23.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$41.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3¼c.
Cobalt Oxide, 70 @ 71 per cent, lb	$1.84
Copper Sulphate, 100 lb	$4.60
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$13.00@$15.00

ALLOYS

Berryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$120.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 per cent, gross ton	$74.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.90@$2.00

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.00@$7.00
Domestic, abrasive, 80 @ 84 per cent	$13.00@$14.00
Dalmatian, 50 @ 55 per cent	Nominal
French, 56 @ 59 per cent	(a)$7.00 @$8.00
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	45@60c.
2 x 2 in.	60@80c.
3 x 3 in.	$1.25@$1.40
3 x 4 in.	$1.50@$1.75
3 x 5 in.	$2.00@$2.25
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c.
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$23.50
Basic	$22.50
No. 2 Foundry	$23.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1939	1940	1939	1940	1939	1940
January	42.750	34.750	20.305	21.892	466.775	395.442
February	42.750	34.750	20.370	20.935	468.472	395.652
March	42.750	34.750	20.280	20.763	468.370	375.212
April	42.750	34.750	20.031	20.713	467,778	351.817
May	42.750	34.949	20.123	21.878	467.988	326.452
June	41.955	34.825	19.505	22.688	468.137	359.560
July	34.944	.....	16.952	.....	468.031	.....
August	35.951	.....	17.719	.....	460.383	.....
September	36.956	.....	22.178	.....	398.820	.....
October	35.726	.....	22.736	.....	400.350	.....
November	34.750	.....	23.378	.....	391.457	.....
December	34.956	.....	23.263	.....	391.830	.....
Year	39.082	.....	20.570	.....	443.199	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1939	1940	1939	1940	1939	1940	1939	1940
January	11.025	11.954	9.912	11.999	43.125	(b)	48.440	(b)
February	11.025	11.148	9.735	11.471	42.188	(b)	47.375	(b)
March	11.025	11.160	9.888	11.407	42.938	(b)	48.120	(b)
April	10.265	11.087	9.820	11.258	42.031	(b)	47.833	(b)
May	9.833	11.079	9.738	11.191	41.656	(b)	47.528	(b)
June	9.775	11.128	9.738	11.216	41.986	(b)	47.528	(b)
July	9.976	.....	9.944	.....	42.899	.....	48.863	.....
August	10.261	.....	10.211	.....	44.685	.....	50.409	.....
September	11.635	.....	11.685	.....	(b)	.....	(b)	.....
October	12.215	.....	12.491	.....	(b)	.....	(b)	.....
November	12.275	.....	12.929	.....	(b)	.....	(b)	.....
December	12.275	.....	12.631	.....	(b)	.....	(b)	.....
Year	10.965	.....	10.727	.....	(c)42.689	.....	(c)48.262	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotations. (b) No quotations. (c) Average for eight months.

LEAD

	New York		St. Louis		London			
	1939	1940	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.826	5.471	4.676	5.321	14.534	14.744	(a)	(a)
February	4.805	5.076	4.655	4.926	14.283	14.417	(a)	(a)
March	4.824	5.192	4.674	5.042	14.660	14.860	(a)	(a)
April	4.782	5.071	4.632	4.921	14.337	14.533	(a)	(a)
May	4.750	5.015	4.600	4.865	14.483	14.679	(a)	(a)
June	4.800	5.000	4.650	4.850	14.564	14.651	(a)	(a)
July	4.854	.....	4.704	.....	14.753	14.856	.....	.....
August	5.043	.....	4.893	.....	16.040	15.885	.....	.....
September	5.449	.....	5.299	.....	(a)	(a)	.....	.....
October	5.500	.....	5.350	.....	(a	(a)	.....	.....
Novemoer	5.500	.....	5.350	.....	(a)	(a)	.....	.....
December	5.500	.....	5.350	.....	(a)	(a)	.....	.....
Year	5.053	.....	4.903	....	(b)14.707	(b)14.828	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton. (a) No quotations. (b) Average for eight months.

TIN

	Straits, New York		Standard, Spot, London	
	1939	1940	1939	1940
January	46.404	46.707	215.435	240.716
February	45.640	45.851	213.906	242.833
March	46.213	47.079	215.375	251.711
April	47.160	46.815	218.389	252.080
May	49.031	51.570	225.591	264.098
June	48.853	54.618	227.511	273.438
July	48.548	.....	229.833	.....
August	48.793	.....	229.869	.....
September	64.588	.....	229.292	.....
October	55.580	.....	229.943	.....
November	52.322	.....	230.000	.....
Lecember	50.740	.....	248.974	.....
Year	50.323	.....	226.177	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.500	5.644	13.682	13.887	(a)	(a)
February	4.500	5.534	13.522	13.780	(a)	(a)
March	4.500	5.750	13.728	13.961	(a)	(a)
April	4.500	5.750	13.443	13.637	(a)	(a)
May	4.500	5.803	13.717	13.938	(a)	(a)
June	4.500	6.235	14.023	14.223	(a)	(a)
July	4.516	.....	14.235	14.435	.....	.....
August	4.719	.....	14.628	14.761	.....	.....
September	6.104	.....	(a)	(a)	.....	.....
October	6.500	.....	(a)	(a)	.....	.....
November	6.500	.....	(a)	(a)	.....	.....
December	5.980	.....	(a)	(a)	.....	.....
Year	5.110	.....	(b)13.872	(b)14.078	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pound sterling per long ton. (a) No quotations. (b) Average for eight months.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1939 (a)	1940 (a)	1939	1940
January	58.400	79.038	20.000	20.000
February	55.000	80.000	20.000	20.000
March	54.259	80.000	20.000	19.769
April	50.000	80.000	20.000	19.000
May	50.000	80.000	20.000	19.000
June	50.000	80.000	20.000	19.000
July	50.000	.....	20.000	.....
August	53.704	.....	20.000	.....
September	64.200	.....	20.000	.....
October	74.600	.....	20.000	.....
November	75.000	.....	20.000	.....
December	75.000	.....	20.000	.....
Year	59.180	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1939	1940	1939	1940	1939	1940
January	11.670	14.000	77.440	156.962	34.440	40.000
February	11.250	14.000	85.227	178.000	35.000	40.000
March	11.269	14.000	87.278	180.921	35.000	40.000
April	11.500	14.000	90.800	173.538	35.000	38.923
May	11.712	14.000	86.769	181.538	35.000	38.000
June	12.000	14.000	86.615	197.360	35.000	38.000
July	12.000	.....	86.960	.....	35.000	.....
August	12.000	.....	84.407	.....	35.333	.....
September	12.910	.....	140.000	.....	40.080	.....
October	14.000	.....	145.600	.....	41.120	.....
November	14.000	.....	134.978	.....	40.000	.....
December	14.000	.....	141.200	.....	40.000	.....
Year	12.359	.....	103.940	.....	36.748	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk 13.415 for May. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1939	1940	1939	1940	1939	1940
January	21.50	23.50	20.50	22.50	21.00	23.00
February	21.50	23.50	20.50	22.50	21.00	23.00
March	21.50	23.50	20.50	22.50	21.00	23.00
April	21.50	23.50	20.50	22.50	21.00	23.00
May	21.50	23.50	20.50	22.50	21.00	23.00
June	21.50	23.50	20.50	22.50	21.00	23.00
July	21.50	.....	20.50	.....	21.00	.....
August	21.50	.....	20.50	.....	21.00	.....
September	22.50	.....	21.50	.....	22.00	.....
October	23.50	.....	22.50	.....	23.00	.....
November	23.50	.....	22.50	.....	23.00	.....
December	23.50	.....	22.50	.....	23.00	.....
Year	22.083	.....	21.083	.....	21.583	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

C. P. Browning, general manager of Britannia M.&S. Company, Ltd., will be in the East for a month.

Lincoln T. Work on July 1 became director of research and development with the Metal & Thermit Corporation.

E. Miles Flynn, of Toronto, was in New York recently after spending several months in Brazil. He left soon thereafter for Cuba.

George W. Danehy, mining engineer, has returned to his Reno office after extended examination work in southern Nevada.

J. E. Hopkins was recently appointed manager of the Fairbanks department of the United States Smelting, Refining & Mining Company at Fairbanks, Alaska.

A. J. MacGeorge, formerly manager of the Imperial mine, Kalgoorlie, has been appointed manager of New Milano, N. L., Mount Monger, Western Australia.

W. H. Williams has been appointed Secretary for Mines in Tasmania, succeeding the late J. B. Scott. He was formerly chief inspector of mines, and came to Tasmania in 1919.

Andrew J. Martin, formerly at the Denver office of the United States Bureau of Mines, has been appointed supervising statistician at the Joplin office of the Bureau, succeeding **J. P. Dunlop,** who has retired.

Guy C. Riddell has been in the San Juan, in southwestern Colorado, for the past month, examining and sampling a group of former producers in the Silverton quadrangle.

Edwin C. Eckel, chief geologist; **Berlen C. Moneymaker,** assistant chief geologist, and **Robert A. Laurence,** geologist, Tennessee Valley Authority, have moved with the Authority's geologic division from Knoxville to Chattanooga, Tenn.

W. R. Brown has resigned as assistant manager and mill superintendent for the Northumberland Mining Company, operating in Monitor Valley, northern Nye County, Nev.

A. J. Klamt, mining engineer, Los Angeles, Calif., has just spent six weeks examining mining properties in Idaho for Eastern clients.

E. W. Skeats is to retire from the professorship of geology at the University of Melbourne in February next. He has been at the University for 36 years.

Harrison S. Lord, Arthur F. Bishop, Louis D. Carlson, and **John Sandburg** have announced that they have effected a merger of all of their gold dredging and other mining interests as a co-partnership to be known as the Lobicasa Company, the headquarters of which will be at Sacramento, Calif.

Dr. Scott Turner was awarded the honorary degree of doctor of science by Kenyon College at its 112th commencement at Gambier, Ohio, on June 10. From 1926 until 1934 Dr. Turner served the Coolidge, Hoover, and Roosevelt ad-

DR. SCOTT TURNER

ministrations as director of the United States Bureau of Mines. Since then he has been vice-president and director of the International Mining Corporation, with offices in New York City.

Leroy A. Palmer, consulting engineer, San Francisco, has been appointed a member of the California State Mining Board by Governor Olson.

Richard Hamilton has been re-elected president of the Chamber of Mines of Western Australia for the 40th year. Mr. Hamilton, who is now 85 years of age, has been president of the Chamber since its foundation.

A. B. Williams has been designated to succeed **H. H. Horton** as manager of Moctezuma Copper Company, a branch of the Phelps Dodge Corporation. Mr. Williams entered the employ of the company in 1910, at Morenci, and Mr. Horton is retiring after 33 years' service.

Endicott R. Lovell, of Hubbell, Mich., has been appointed general superintendent of Calumet & Hecla Consolidated Copper Company. He will be succeeded as superintendent of Calumet & Hecla Smelting & Refining Department by **Herman C. Kenny.**

Samuel H. Dolbear has been appointed to the raw-material division of the National Defense Advisory Commission as a consultant on chromium. Others designated as mineral consultants for the Commission are: **Howard C. Sykes,** mica; **Robert L. Hallett** and **Irwin Vogelsang,** tin; and **Harris K. Masters,** tungsten and antimony.

S. M. Manning, who was manager of Relief-Arlington Mines, Ltd., at Erie, B.C., for six years, has left for Arabia, where he will be assistant manager of the Saudi Arabia Mining Syndicate holdings at Jedda, on the Red Sea. **J. C. McCutcheon** is the new manager of Relief-Arlington.

Charles A. Banks has been appointed by the Canadian Government to serve as representative in England of the Canadian Department of Munitions and Supply. On May 24 last Mr. Banks delivered the 66th commencement address to the graduating class of the Colorado School of Mines, at Golden, Colo., on which occasion he was given the honorary degree of doctor of engineering.

James H. Critchett, vice-president of Electro Metallurgical Company, vice-president of Union Carbide and Carbon Research Laboratories, Inc., New York, and former president of the American Electro Chemical Society, has been appointed a member of the National Research Council. Mr. Critchett will serve on the Division of Chemistry and Chemical Technology.

John Van Nostrand Dorr, on May 31 and June 7, respectively, made the commencement addresses at South Dakota School of Mines, Rapid City, S. D. and the Michigan College of Mining and Technology, Houghton, Mich. Both institutions conferred on Mr. Dorr honorary degrees of doctor of engineering, in recognition of his contributions to chemical, metallurgical, and sanitary engineering practices.

J. S. Stewart writes under date of May 24 from Posta Zvecan, Jugoslavia, that Trepca Mines, Ltd., started its lead smelter on Dec. 21 and that the Newnam Scotch hearth, with its auxiliary equipment, has exceeded all expectations in the production of lead from Trepca concentrates. The refinery got under way at the middle of February and has been functioning without trouble. The greatest difficulty has been to get in supplies promptly owing to war conditions. Zvecan has been a peaceful spot, and the war has had little effect on living conditions up to the time of writing.

▼ ▼ ▼

OBITUARY

Arthur Grinnell Burritt, 80, mining engineer and geologist, died on June 4.

William Koerner, general manager of Magma Copper Company at Superior, Ariz., since 1925, died in Portland, Oregon, on June 30 at the age of 54.

Curtis Ross Martin, of Picher, Okla., general superintendent for the C. Y. Semple Mining Company for ten years, died May 28 at Joplin following an appendectomy.

Louis H. Metzgar, general superintendent of Alaska Juneau mine, died in San Francisco on June 2. An appreciation of Mr. Metzgar's contribution to the mining industry, by P. R. Bradley, president of Alaska Juneau, will be presented in the August issue of *Engineering and Mining Journal.*

Henry B. Kingsbury, prominent mining man of Wallace, Idaho, died sddenly on June 12. He was president of Pennaluna & Company, in Wallace, and also president and general manager of the Clay-

ton Mines Company. He was 48 years old.

William Charles Henry Wilson, identified with mining in British Columbia and the United States for 40 years, died early last month in Victoria, B. C., at the age of 64. Mr. Wilson had been active professionally in Idaho, California, Tennessee, Arizona, and Ontario, as well as in British Columbia, where he was formerly comptroller of the British Columbia Copper Company. He had also been on the staffs of the Mountain Copper Company, Tennessee Copper Company, and the British-America Nickel Company, of Sudbury, Ont., of which last-named company he was assistant manager. For many years he practiced as consulting mining accountant. He also was associated with the British Columbia Government as mining accountant and special auditor of mines. He is survived by his widow, Madeleine M. Wilson, and a son.

P. W. George

On page 60 of the *Engineering and Mining Journal* for June, 1940, appears an obituary notice as covering the death of P. W. George. You state therein that he "died recently in the bush from unknown causes." Would you kindly correct this statement to read that Mr. George died from a sudden heart attack while on a prospecting and examination trip in the vicinity of Buchans Junction, Newfoundland.

GEO. G. THOMAS,
Manager Buchans Mining Company.

▼ ▼ ▼

LETTERS

Philippine Base Metals Production and Value

The Editor:

IN THE INTEREST of accuracy, we offer the following corrections covering the figures given in an article on Philippine Base Metals in your April, 1940, issue:

Actual shipments from the Masinloc chromite deposit in Zambales made during the calendar year 1939 totaled 73,363 tons; value 876,650 pesos. (Both figures above given are net returns.)

The following are the correct figures for shipments from the Florannie property for the calendar year 1938: 32,739 tons—value 801,912 pesos.

Shipments from the Consolidated Mines Contract property for 1938 (net returns): 10,022 tons; value 50,050 pesos.

In 1939, 7,261 tons were shipped from the Florannie property; value 187,525 pesos. Shipments from the Florannie property were made both to the United States Vanadium Corporation and to the Vanadium Corporation of America up to 1939, and during 1939 shipments were also made to E. J. Lavino & Company, Philadelphia.

During 1940, to date, including a vessel now at Masinloc loading 4,000 tons, a total of 48,300 gross tons has been shipped from this property; value, f.o.b. vessel, 579,600 pesos.

Shipments made include shipments to the United Kingdom and Australia as well as to the United States during this period.

A. F. DUGGLEBY,
Second vice president,
Benguet Consolidated Mining Company.

Silicate Nickel Ores in New Caledonia

The Editor:

ONE of the several letters of comment on my article describing the silicate nickel ores of North Carolina, published in your October, 1939, issue, has recently been received from Monsieur R. Pognon, of Noumea, New Caledonia.

Since the data supplied by Mr. Pognon on the similar garnierites of his far-off French island are undoubtedly authentic and not always readily available, I believe the following excerpts from his letter may be of interest:

"For the past two or three years," he writes, "the export of ore to Japan has been under way. The average grade of these ores was between 4 and 4.25 per cent nickel. Last year the tenor of the ore smelted on the island was as low as 3.75 per cent nickel. In April, 1940, the export of ore to Japan was discontinued by order of the French Government."

Mr. Pognan states further that the ore production in 1939 was 350,000 tons, of which some 50,000 tons was exported (presumably to Japan), while the remainder was smelted "to 8,000 tons of matte carrying 77-78 per cent nickel." "In 1940, it is expected the production will attain to 400,000 tons, yielding about 9,000 tons of matte."

Since the writing of this communication on April 25, 1940, the situation has changed, disastrously. Now the refineries for those mattes in Belgium and France are in the hands of the Germans, and it is certain that the British will prevent further shipments to those enemy plants or elsewhere in Europe. The question, therefore, arises, "Will the Caledonian production now go exclusively to the Japanese, who would be glad to obtain the raw material, or will the matte be permitted to come to the United States?"

Until 1930, thousands of tons of these mattes were refined annually in this country; today, no primary nickel whatsoever is refined here, and the metal is one of the most important of our deficient strategic materials. It is extremely desirable, therefore, to reestablish this industry here, at least during the period when France herself is unable to utilize these raw materials.

G. W. PAWEL

Value of Tables in Reconnaissance and Mapping

The Editor:

THE MAY, 1940, ISSUE of your magazine carried an article by W. B. Phillips which I found very interesting. This article was on page 55 and was entitled "Reconnaissance and Mapping Speeded by Tables." Reading this article brings to mind the fact that apparently many surveyors and engineers in the mid-west and east have overlooked the value of the rapid, yet fairly accurate, methods which Mr. Phillips has pointed out. Here in the mountain country most men who have any reconnaissance work to do use similar methods. I believe that the details of some of my own work might provide an additional thought for those interested.

The small pocket volume, "Standard Field Tables," published by the General Land Office, provides all the necessary traverse table figures, in addition to other useful information. These tables can be used as rapidly as a more condensed version because practically no calculation is required. Usually it is more satisfactory to use two helpers. One man leads, acting as head chainman and rodman. He uses a light-weight range pole, equipped with a target and a circular level. This head chainman also carries a ring of pins, one of which he sets at each station point. The other man — as rear rodman — carries only a light range pole and a pin ring.

Readings are taken in the same manner as that outlined by Mr. Phillips — with these two exceptions: At every station a *backsight* reading is taken on the bearing of the course. A stone is dropped from the eye to the pin to determine an approximate plumb position. This is an aid to chaining.

Work on this program moves practically as fast as on the program which Mr. Phillips has outlined. As very definite advantages, bearing on the accuracy of the result, are these three points: In plotting the traverse, all angles can be "turned" by using the backsight and foresight readings, just as in transit work. By using a level on the leading rod and a rough plumb position at instrument the chaining is more accurate. By counting the pins, which the rear rodman collects, it is an easy matter to check on the number of shots made and compare these with the records entered, thus allowing for the discovery of any errors of omission.

Part of a page from one of my field books shows these records clearly. All observations are entered on the left page of a standard "Mining Transit Book," using only every other line. On the other page any necessary notes pertaining to stations used are made. When sketches are needed they are very quickly made on the 10x10 cross-section rulings.

Courses F. S.	B. S.	Slope	Dist.	Horz.	Vert.	
N 20 W	.....	— 8	200.00	198.06	27.84	Other Page—
N 10 E	S 18 E	+10	200.00	196.96	34.72	For odd
N 26 E	S 11 W	+14	200.00	194.06	48.38	notes.

Work done by the method described has been very satisfactory. Surprisingly accurate results can be obtained in this manner.

J. H. HANNAN

What Metal Statistics Show

WHEN France asked for peace terms on June 17, that country fell into Germany's sphere of economic influence, thereby removing the necessity for her to acquire a substantial volume of copper for defense purposes. Late in May France sought to obtain copper at a rate of 25,000 tons a month over the September-November period, and foreign producers arranged their production schedules accordingly. It is now believed these schedules will require revision as the foreign copper market becomes more narrow. The table below on exports indicates this trend. It is estimated France has acquired about 250,000 tons of copper since September.

Observers believe domestic producers are also pondering upon their production schedules, but in view of the national defense program getting under way, it is believed curtailment will not be necessary. Some properties may, however, proceed with their customary brief summer shutdown for repairs.

Statistics for the month of May showed that stocks of refined increased 9,544 tons. Production of blister was 82,607 tons, of which quantity the mine group accounted for 71,504 tons.

The duty-free copper statistics of Copper Institute for April and May follow, in short tons:

Production:	April	May
Crude	(b)84,366	82,607
Refined	80,964	86,029
Deliveries to customers; refined:		
Domestic	68,665	69,467
Export	2,974	7,018
Totals	71,639	76,485
Stocks, refined (a)	169,120	178,664

(a) End of month. (b) Corrected.

Exports of refined copper from the United States, consisting of foreign metal refined in bond and domestic copper, during March, April, and May, in short tons, according to the Department of Commerce:

To:	March	April	May
Belgium	791	....	....
Denmark	....	6	....
France	2,718	3,435	3,780
Germany	....	....	....
Great Britain	3,248	6,122	5,432
Hungary	716	744	....
Italy	7,286	3,025	14,702
Netherlands	1,380	37	....
Russia	5,584	....	....
Sweden	2,557	....	....
Switzerland	1,157	505	1,351
China and Hongkong	134	288	....
Japan	3,943	4,674	2,916
Other countries	2,644	1,892	1,762
Totals	32,158	20,728	29,943

▶LEAD—The April and May statistics for refined lead, according to the American Bureau of Metal Statistics, in tons, follow:

	April	May
Stock at beginning	74,692	63,610
Production:		
From domestic ore	31,192	37,918
Secondary and foreign	4,151	8,350
Totals	35,343	46,268
Domestic shipments	46,496	46,919
Stock at end	63,463	62,955

▶ZINC—The April, May and June statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	April	May	June
Stock at beginning	73,611	81,234	75,036
Production	54,601	52,979	49,155
Production daily rate	1,820	1,709	1,639
Shipments	(a)46,978	(b)59,177	53,518
Unfilled orders	45,326	55,417	59,043
Stock at end	81,234	75,036	(c)70,673

(a) Includes 386 tons exported.
(b) Includes 3,908 tons exported.
(c) Includes 2,342 tons exported.

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1934	69.59
1930	82.87	1935	74.66
1931	60.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67
1939	77.71		

	1938	1939	1940
January	75.56	77.12	80.85
February	73.43	76.89	77.23
March	72.41	77.09	77.94
April	71.19	74.79	77.19
May	69.15	73.61	77.68
June	67.55	73.17	78.85
July	72.95	71.95	.....
August	73.94	73.88	.....
September	74.70	83.07	.....
October	77.61	84.25	.....
November	78.36	83.80	.....
December	77.13	82.89	.....

Figures covering operations of the Prime Western division, for April, May and June follow:

	April	May	June
Stock at beginning	32,179	35,258	31,707
Production	22,962	21,487	19,797
Shipments	19,883	25,038	22,726
Stock at end	35,258	31,707	28,778

▶QUICKSILVER—Estimated consumption of quicksilver in the United States during April was 1,900 flasks, or about the same as in March, but lower than in the first two months of the year.

Quicksilver statistics, compiled by the Bureau of Mines, covering the three months ended April 30, in flasks of 76 lb.:

	Feb.	March	April
U. S. production	2,200	2,500	2,700
Exports	115	1,226	316
Imports (a)	3	20	1
Consumption	2,000	1,800	1,900
Consumers' stocks	(b)9,900	9,300	9,600
Dealers' stocks	1,200	1,500	1,800
Producers' stocks	(c) 346	859	624

(a) Imports for domestic consumption. (b) Revised. (c) Stocks held by producers who report on monthly basis.

The market for quicksilver has advanced from a monthly average of $84.41 per flask last August to $173.54 in April.

Estimated Use of Copper in the United States

Use of copper in the United States during the last four years, estimated by the American Bureau of Metal Statistics in its Year Book for 1939, in short tons:

	1936	1937	1938	1939
Electrical manufactures (a)	164,000	212,000	150,000	185,000
Telephones and telegraphs	26,000	40,000	30,000	39,000
Light and power lines (b)	72,000	83,000	62,000	67,000
Wire cloth	6,500	6,800	6,000	8,000
Other rod and wire (i)	90,000	102,000	60,000	95,000
Ammunition	11,900	14,100	12,500	14,500
Automobiles (c)	108,000	112,000	55,000	85,000
Buildings (e)	71,000	70,500	67,500	89,000
Castings (d)	39,000	40,000	31,000	33,000
Clocks and watches	3,400	4,000	3,000	3,600
Copper-bearing steel	3,900	4,600	2,600	4,200
Radiators, heating	2,000	2,100	2,000	3,600
Radio receiving sets	24,000	23,100	21,000	27,000
Railway equipment (f)	4,000	7,100	1,700	2,700
Refrigerators (h)	15,000	13,500	6,700	10,000
Shipbuilding (h)	5,000	6,400	6,000	8,500
Air conditioning (g) (h)	6,400	7,200	6,000	6,000
Other uses (j)	65,300	66,600	46,200	68,000
Manufactures for export	31,600	45,000	38,800	51,900
Totals	749,000	860,000	608,000	801,000
Use in pounds per person	11.66	13.31	9.34	12.21

(a) Generators, motors, electric locomotives, switchboards, light bulbs, etc. (b) Transmission and distribution wire and bus bars; accounting only for public utility companies. (c) Does not include starter, generator, and ignition equipment. (d) Bearings, bushings, lubricators, valves and fittings. (e) Excludes electrical work. (f) Includes air conditioning. (g) Other than railway. (h) Exclusive of electrical equipment. (i) Includes industrial wire and cable, wire in buildings, railway cars and ships, radio broadcasting, railway and municipal signalling, railway electrification, trolley wire, rod and wire for government projects, blasting wire, flexible cord, and sundries. (j) Includes condenser tubes, oil-burner tubing, welding rod, screw machine products, nickel-silver and phosphor-bronze products, rivets and burrs, toilet pins, eyelets and grommets, electrotyping and engraving sheet, spark plugs, inner tube valve stems, jar tops and rouge boxes, flash light tubes, kerosene lamps, kitchen utensils, kitchen range boilers, linotype matrices, safety razors, blasting caps, asbestos textiles, water meters, thermostats, soldering coppers, yacht fittings, coinage, washing machines, household water heaters, fire extinguishers, pumps, engines and sundry machinery, etc., all reckoned in terms of copper content.

Surface plant at the Black Oak mine, Garden Valley, Calif. Mill capacity is 50 tons, the plant also treating ore from the near-by Golden Oak mine. Both properties are operated by Russell T. Wilson. In the background is the headframe of the Davey mine

CALIFORNIA

Walker Mine Maintaining Steady Copper Output

Mill capacity to be increased by addition of screening equipment—Shaft at Cherokee mine to be deepened

▶ Production around 1,600 tons of copper ore a day is maintained at the Walker mine, in Plumas County, a subsidiary of the International Smelting & Refining Company, Salt Lake City, Utah. The workings below the main haulage level, or the 700 level, have reached a depth of 800 ft., with five separate orebodies under exploitation. Shrinkage stoping is practiced. Increase of mill capacity by installation of additional screening equipment is planned. About 500 men are employed under the direction of H. M. Hartmann, manager.

▶ About 75 men are employed at the Cherokee mine, near Greenville, operated by the A. L. Merritt interests, of San Francisco. Underground, operations have been started to sink the main three-compartment shaft another 100 ft. to 350 ft. to be followed by lateral development. The flotation mill is treating about 200 tons a day. Frank Humphrey is superintendent.

▶ Indian Valley Mining Company, operating the Standart mine, near Greenville, Plumas County, has recently completed a new 250-ton flotation mill, and is currently treating more than 200 tons of ore a day. Gus Johnson is general superintendent.

▶ Eighty stamps are dropping at the Empire mill of Empire Star Mines Company, Ltd., Grass Valley, Nevada County, handling ore mined in the Empire mine and the adjoining Pennsylvania mine. In the Empire mine a new hoist is being installed on the 4,600 level, and a 100-ft. headframe with a built-in crusher has been completed recently at the Pennsylvania shaft. Production from the Pennsylvania is hauled to the Empire mill in five-car trains drawn by trolley locomotives. At the North Star unit, development is on the 10,000 level (about 4,300 ft. vertical), with stoping in progress on numerous levels. At the mill 60 stamps are in operation, crushing around 350 tons a day. Additional jig and flotation equipment has been added to the grinding and flotation departments. John Mann is general manager.

▶ At the Boundary mine the main shaft has been rehabilitated and deepened an additional 250 ft. to 500 ft. The property is operated by John Becker, and A. Hellings is mine superintendent.

▶ Mountain Copper Company, Ltd., is treating some 700 tons of gold-bearing gossan in its cyanide plant at Iron Mountain, Shasta County. J. G. Huseby, general superintendent, directs operations, and D. L. King is mill superintendent.

▶ New equipment in course of installation at the New Brunswick mine of Idaho Maryland Mines Corporation, Grass Valley, Nevada County, includes new ore bins with appropriate conveyors, a 600-hp. double-drum hoist and a 480-hp. single-drum hoist for the main shaft, and additional compressor and grinding machinery. The mill is now treating about 1,000 tons a day. At the Idaho Maryland unit all milling units are operating at full capacity, the old Idaho stamp mill handling production (about 60 tons) from the Bullion mine exclusively. Errol MacBoyle is managing director, and Albert Crase, manager.

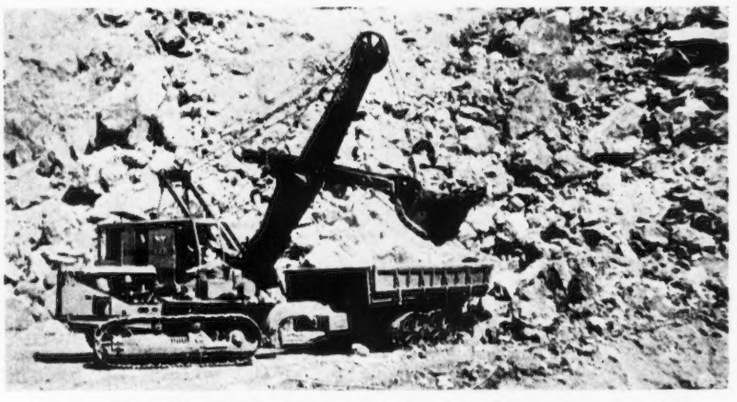
▶ At the Alabama mine near Penryn, Placer County, shaft sinking operations are proceeding on schedule. A total depth of more than 1,100 ft. has been reached, the goal being 1,200 ft. The mill is equipped with modern crushing, grinding, amalgamation, jig, and flotation machinery, making a 97 to 98 per cent recovery. The property is operated by Alabama-California Gold Mines Corporation, George I. Barnett, general superintendent.

▶ Middle Fork Gold Mining Company, C. W. Plumb, general manager, has completed the installation of a new 75-ft. steel headframe and hoisting machinery at its Sliger mine, near Georgetown, El Dorado County, and is preparing to sink the new shaft an additional 600 ft. The capacity of the flotation plant was recently increased to around 150 tons through the addition of a 5x7-ft. Eimco ball mill and classifier. E. H. Syms is superintendent.

▶ Iron Mountain Investment Company, a subsidiary of Mountain Copper Company, Ltd., operator of the Hornet mine and a gold-bearing gossan operation at Iron Mountain, Shasta County, and the Big Canyon property at Shingle Springs, El Dorado County, now closed, has recently obtained a lease and option to purchase the Robert Veerkamp mine, also known as the Defiance, in the Garden Valley area of El Dorado County. Development work has been started under the direction of J. M. Basham.

▶ More than 300 tons of gold-bearing gossan are treated at the cyanide plant of Willow Creek Mines, Inc. near French Gulch, Shasta County. Corwin L. Cooper is superintendent.

▶ The New Idria quicksilver property, in California, controlled by Theodore Hoover interests, has been sold to a syndicate composed of E. L. Elliot, A. A. Schlessinger, both of Milwaukee, and C. H. Jackson, Jr., of Santa Barbara, Calif., through Van Alstyne, Noel & Company, New York investment house. H. W. Gould is to continue as manager.



At Iron Mountain, Shasta County, the Mountain Copper Company, Ltd., is exploiting a gold-bearing gossan and treating 700 tons of ore per day in their cyanide plant. Preparations are under way to mine by top-slicing method an area of gossan ore covered with excessive overburden.

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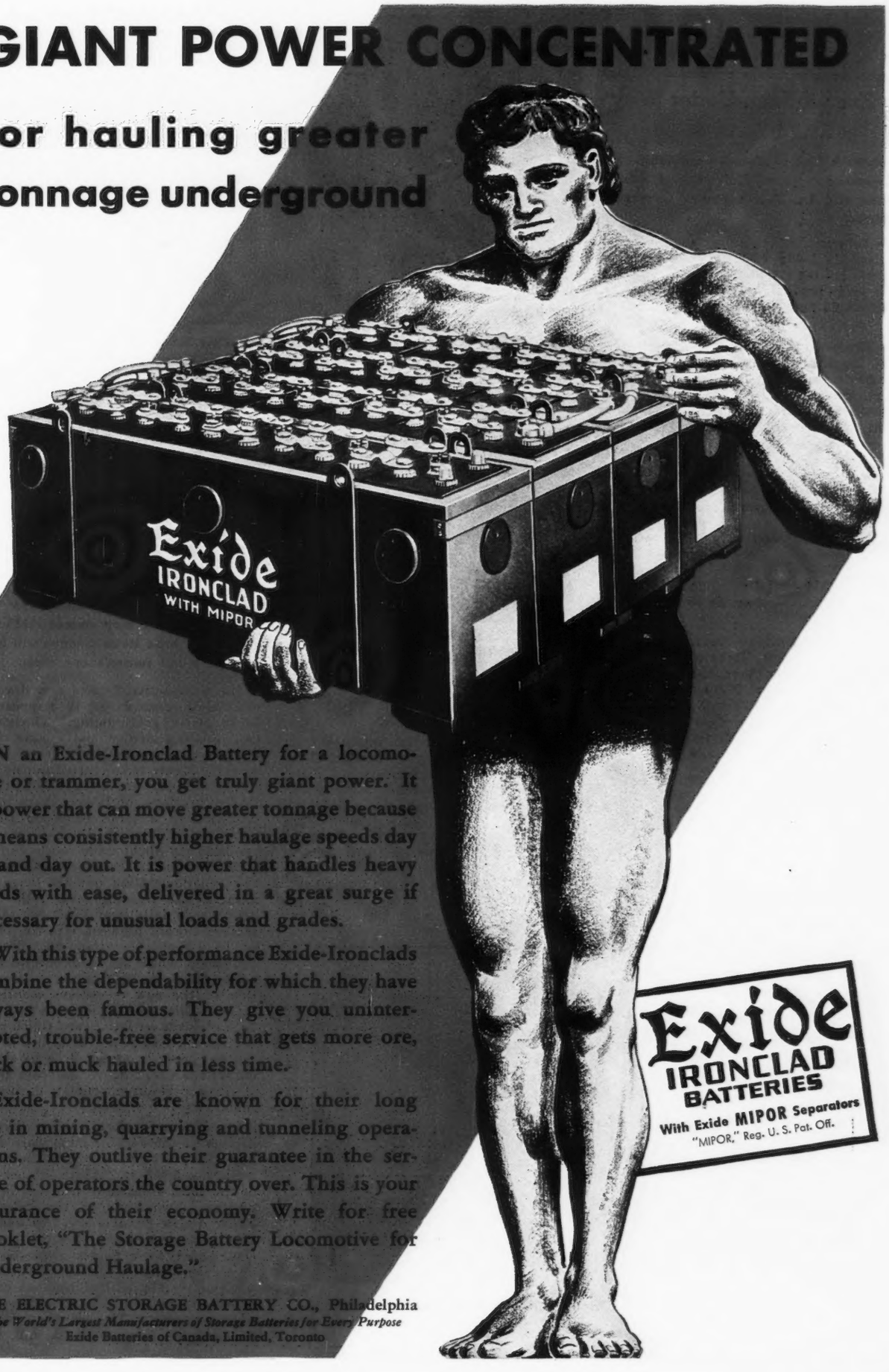

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ARIZONA

Examination Under Way At 79 Lead Mine

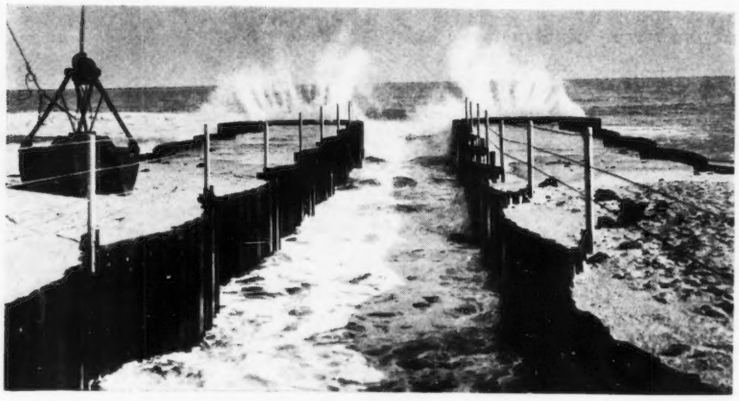
Shattuck Denn Mining Corporation has reopened property—University of Arizona has established a separate College of Mines

▶ An examination, under option agreement, is being made by the Shattuck Denn Mining Corporation of the 79 mine, a lead producer, near Hayden Ariz. About 25 men are employed and George Warner, of Bisbee, is superintendent.

▶ The new mine and metallurgy building at the University of Arizona will perpetuate the memory of Dr. James Douglas, leader of the Phelps Dodge mining interests for nearly 40 years. The building will provide nearly 30,000 square feet of floor space in two stories and a finished basement. Equipment will be modern and will be flexible in research uses. Of special importance will be experiment and testing equipment for studies of mine dusts. Mining engineering has been taught at the University of Arizona since 1891, having established the institution as a school of mines, but action this year by University regents formed the separate college of mines that opened July 1.

▶ The Ed. Williams tungsten property in Francis Creek, Mohave County, and adjoining claims have been taken over by The Continental Mining Corporation, 80 Broad St., New York, N. Y. Development work is in progress and a 1,000 ft. tunnel is being driven. The company is building a 100 ton mill.

▶ The Tonopah Mining Company, which took over the Old Moss mine, in the Silver Creek section of Mohave County, gave up its option after about two months' development work. Hellier and Kellogg, who turned the property to the Tonopah company, however, will continue its operation. It is reported that engineers representing New York interests are now examining the mine.



Magnesium from the sea. Near the estuary of the Brazos River, which flows into the Gulf of Mexico at Freeport, Tex., the Dow Chemical Company will erect a plant for the recovery of magnesium from sea water. A water intake as shown above will supply the plant with a capacity of 12,000,000 gallons of sea water daily. It is estimated that one cubic mile of sea water contains 5,700,000 tons of magnesium.

▶ A carload of silver-lead ore is being shipped weekly from the Hall and Woodpecker groups of claims southwest of Superior. E. M. Perkins, of Superior, has the groups under lease and option from the owners, Pat Gorham and associates.

▶ Good gold-silver ore was encountered recently in the sinking of a winze on the Hardy mine, northwest of Duncan. The strike is reported to be between the 500 and 600 levels. Two shifts are now at work. Joe Hardy, of Duncan, is the owner of the property and has leased it to Neilson, Williams, and Farrish of Ely, Nev.

▶ Satisfactory results are reported from the new cyanide plant at the East Camp mine, and bullion shipments are going out regularly to the mint. Ore is now being hoisted through the new shaft completed to the 600-ft. level. The property is situated 22 miles east of Duncan in the Steeplerock district and is owned by the East Camp Exploration Syndicate, of Salt Lake City, Utah. Fred E. Turner, Sr., is manager of the company.

The new mines and metallurgy building at the University of Arizona, Tucson, Ariz., which is a gift of the Phelps Dodge Corporation to the University in memory of James Douglas, founder of the corporation.

MONTANA

Gold Placer Mining Expanding in State

Several areas being treated and gold output this year may exceed 1939 production, as some large dredges will benefit from a full season's operations

▶ The most active field of new development in Montana during 1940 appears to be in placer gold mining. Though no new floating dredge units have been brought in this year, a number of large-capacity plants were started during late spring and early summer. Among these, Cooley Brothers, of Denver, have begun operation of a large plant on Indian Creek near Townsend; Douglas interests are handling about 2,000 yards daily at a point on Indian Creek at a point above the Cooley operation, and the Bergstrom interests are treating several thousand cubic yards daily near Winston. Above Boulder toward Elkhorn, Winston Brothers have begun operations with dragline equipment which also is of several thousand yards' daily capacity. In addition to the new operations mentioned, active drilling and exploration for placer is in progress on Immigrant Gulch above Livingston, on Spring Creek below Norris, and work is expected to be started on Willow Creek above Harrison and in the Upper Madison country during the summer.

▶ Continuous exploration by diamond drilling at the Jardine mine since January, 1939, has resulted in 33 holes, aggregating 5,393 ft. About 12 per cent of the total distance drilled was in vein matter. Two-thirds of the holes cut either ore or possible ore. In addition to disclosing new ore, the drilling has contributed to a better understanding of the geological structure of the mine, particularly the faulted portions of No. 4 vein, which have long been a subject of controversy. The company is now doubling the capacity of its mill, using an entirely new flowsheet.

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NEWS FROM Washington

By Special Correspondent

MILITARY PREPAREDNESS is taking all official attention of Washington. Everyone is trying to help, but many are getting in the way of programs in their anxiety to secure defense positions or authority. Political considerations are relatively unimportant, but by no means negligible.

Only time can disclose whether the efficient business men of the Defense Commission will retain enough authority to exercise fully their skills. There is some evidence that the New Dealers are much disappointed that they were not put in charge. Secretary Ickes is the most obvious of these. His appointment of a Defense Advisory Commission in the Department of the Interior is nominally to "cut through routine procedural difficulties," but surrender of Department authority has already been shown to be an unwelcome aspect of the new arrangement. This may materially influence the relationship between the Bureau of Mines and the United States Geological Survey on one side and the defense mineral planners on the other. Initially, there is splendid cooperation. If the technical men have their way this will be permanent. But there is some cause for skepticism evident even before the middle of July.

Defense Minerals

THE GENERAL ASPECTS of the strategic minerals program are discussed in an article elsewhere in this issue of *E.&M.J.* (see page 33). Supplementing that general statement it is possible only to indicate a limited amount of the new organization plan.

Initially Dr. C. K. Leith, named as an assistant to Mr. Stettinius, utilized the offices and facilities of the Bureau of Mines as his headquarters. He has had splendid and sincere cooperation there. The support of the U.S.G.S. staff is equally cordial. But, of necessity, this work is being moved into the headquarters of the Defense Commission at the Munitions Building. Policy decisions will be made there.

Other advisers to Mr. Stettinius on minerals include Samuel H. Dolbear on chromium, Howard C. Sykes on mica, Robert L. Hallett and Erwin Vogelsang on tin, and Harris K. Masters on tungsten and antimony.

Secretary Ickes named a seven-man "Defense Resources Committee" in order to mobilize the organization of the Department. This committee is to work under the chairmanship of First Assistant Secretary E. K. Burlew. In addition to specialists on grazing, power production, public lands, and related matters, the two mineral members are Dr. W. C. Mendenhall, Director of U.S.G.S., for mineral and oil resources, and Dr. R. R. Sayers, Director of the Bureau of Mines, for "mineral production, metallurgy, gas, and anti-gas devices, explosives, helium, and related subjects."

The mineral industries will also have certain dealings with other defense groups, perhaps including the chemical advisers to Stettinius, who are headed by Dr. E. R. Weidlein, of Mellon Institute, and those who intend to police prices for the President, especially Leon Henderson, of S.E.C., who will watch industrial and raw material prices.

To accelerate business dealings of the procurement division of the Treasury Department an experienced businessman has been named to succeed naval Captain Harry E. Collins, who has left the government service. The new executive is Donald M. Nelson, former executive vice-president of Sears-Roebuck & Company. This unit continues as the major purchasing agency for minerals intended for stockpile purposes.

Mine Taxes

MINING and metallurgical companies will pay larger taxes next year presumably of the same size as other business enterprise. In the early stages of new tax legislation it appears that the mining industry, and mining engineers as individuals, will be affected primarily by the changes of income tax rates. Increased income taxes include principally an increase of 1 per cent on earnings in each taxable income class plus a super tax for defense purposes of 10 per cent additional. This super tax applies not only to income but also to capital stock, excess profits, estate and gift taxes. None of the excise taxes of interest to the mining industry are subject to this same 10 per cent super tax. It is explicitly provided that the excise taxes on coal, petroleum, copper, lumber, and some other commodities, are not to be so raised.

A general tax revision bill still further burdening industry and individuals is expected to be formulated later this year. It will presumably affect 1940 incomes, even though it may not pass until close to income-tax report time next March. The form and magnitude of the new levies has not had any serious thought or discussion as yet here in Washington; but with the extra billions per year being spent it is sure that the new tax bill will correspondingly increase the cost of doing business.

Strategic Surveys

FOR THE FIRST time in its history, the United States Geological Survey will go outside the United States in search of deposits of strategic minerals, as a part of the defense program. With approval of the Interdepartmental Committee on Cooperation with American Republics, the U.S.G.S. has been given $25,000 to explore for such deposits in Latin America. Five projects originally were set up, costing $60,000. With the appropriation reduced, the Survey probably will select only two manganese and chromium ore deposits in Brazil, and tin and antimony deposits in Bolivia.

A cable survey among American consuls to locate exact amounts of strategic and critical materials throughout the world, and their availability to the United States, was started late last month by Stettinius' division of the Defense Commission. The step was preliminary to gobbling up whatever stores can be carted away with the $60,000,000 specifically made available for strategics in the increased national defense appropriations. Indications were that available quantities shown in the cable replies were to be snapped up and the nearest ship ordered to pick them up. At least in the initial stage the Defense Commission, working with the Army, Navy, and Bureau of Mines, is operating on the policy of getting "what we can, where we can, and as quickly as we can."

Mines Bureau engineers are continuing their field work in accordance with the methods and program set up in 1939. The regular appropriation of $350,000 for about eight field parties will be doubled, if the recommendations of mid-June are approved, as hoped and expected. This presumably will more than double the speed of field work.

As the fiscal year began on July 1, the Bureau and the Geological Survey had reviewed many hundreds of projects either separately or jointly. The Bureau work, according to methods described by Jackson (see *E.&M.J.*, Dec. 1939.) will be applied to something over 100 field locations thus far identified. A limited number of these have been scheduled for immediate action or are so outlined as to be sure of attention during the current year. About 30 others have been sufficiently investigated to be on the list for probable thorough exploration. Something more than 50 further projects have some prima facie evidence of value and will ultimately receive at least reconnaissance attention. Bureau engineers estimate that it will take a trifle less than $2,000,000 to complete this undertaking. Some have thought it probably could be done in one year, but available experienced men are hardly adequate for that, even if Congress granted such a sum, which it probably will not.

Dr. Sayers' résumé of progress (released in June) has resulted in some differences of understanding. Broadly speaking, the report of the first year's work is optimistic as to valuable and useful deposits for emergency periods. But very few, if any, commercially workable locations have been opened up by this work, if one appraises them from a normal or peace-time competitive point of view. This, however, is not the purpose of the undertaking. It has, rather, the objective of identifying non-commercial reserves which could be developed when imports are unavailable, more or less regardless of cost. The metals being investigated are, as formerly, manganese, chromium, quicksilver, tungsten, nickel, tin, and antimony.

Low-Grade Ore Project

BOTH the mining and metallurgical groups of the Bureau of Mines have been urging that Uncle Sam become actual owner and processor of low-grade strategic minerals. New appropriation for this purpose was not requested, as it was believed better to have funds provided from the President's military contingency fund. The sum discussed is

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$2,000,000. On the recommendations of Army and Navy men, this amount was recommended to the President by a House vote, but the decision remains with the Chief Executive as to what work will be done, how much money will be allotted, and the scope of the work desired. Emphasis is on manganese; but other metals could also be so developed, if the President chooses.

Two distinct projects are contemplated if the full sum and adequate authority are given by the President. The first of these will correlate with the field surveys of the mining division. The second would be purely a metallurgical undertaking. But both parts of the project would contemplate putting Uncle Sam directly into ore ownership, milling, and smelting. None of the policies has been finally fixed, but the form of recommendation for this work is about as follows:

The United States will plan to buy low-grade ores. The government will pay for these at, for example, about 60 per cent of the market value of the contained metal, measured by the prices for high-grade, directly usable ores. The lower prices paid would contemplate substantial expenditures by the government in its own ore-dressing and metallurgical works for the beneficiation of the low-grade minerals. The terms of purchase of the low-grade ores and which types of ore should be purchased will vary from time to time according to the circumstances of need, interruption of foreign supplies, and prospect of successful processing.

The government would embark on a commercial program of building plants to beneficiate the minerals purchased from small mine owners. It would undertake to develop novel methods of concentration and the preparation of sintered concentrate in forms suitable for use in the customary work of industry. Concentrates would be put into a reserve stockpile to be used in emergency instead of imported ores. The government would presumably allocate these concentrates to commercial firms for use on government orders subsequently placed.

In the contemplated metallurgical work, one major item is a great electrochemical smelting unit to be located at Boulder Dam, Nevada. It would undertake to make commercial development of some of the ideas which have been proposed by the metallurgists of the Bureau. The scope and geographic location of this work suggest the reason that Representative Scrugham of Nevada has been the major sponsor of the recommendation in Congress.

Wage-Hour Contracts

MANY MINING UNITS may be able to take advantage of the revised Interpretative Bulletin No. 8 of the Wage and Hour Division which in some measure exempts employers from the time-and-a-half pay for hours over 42 per week. This new ruling of Administrator Philip B. Fleming applies to firms which make an annual or semi-annual contract of employment with their workers. If such contract provides that no employee is to work more than 1,000 hours during any period of 26 consecutive weeks, then the 42-hour limit on single weeks may be waived.

The Administrator explains that this waiver of the over-time pay provisions is intended essentially to increase the opportunity for employment under most efficient conditions. In effect, the revised form of this ruling gives somewhat greater freedom of employment contract between the employer and organizations of the workers. But the Administrator may not under the law actually waive any of the fundamental requirements by loose interpretations. The purpose of this revision of the Bulletin regarding bargaining agreements is, therefore, solely to clarify the law for the mutual advantage of workers and their employer, not to lighten responsibilities of the employer.

Export Ban on Key Materials

ON JULY 2 the President placed a virtual embargo on selling to foreign countries any materials deemed essential to national defense, and of which there may be an actual or potential shortage in this country. By proclamation, licenses will be required for the export of a large number of key commodities; and by military order, Lieut. Col. Russell L. Maxwell was designated Administrator of Export Control. His authority is final, superseding that of the State Department in determining what may be sold abroad. Export-license control was proclaimed immediately following the signing of "An Act to Expedite the Strengthening of the National Defense."

Mineral products covered by the proclamation include: aluminum, antimony, asbestos, chromium, graphite, industrial diamonds, manganese, magnesium, mercury, mica, molybdenum, platinum group metals, quartz crystals, tin, tungsten, and vanadium. Severe penalties for violation or circumvention of the export control measures are provided in the legislation under which the President acted, including a fine of as much as $10,000 and imprisonment up to two years, or both.

The tremendously augmented program for mechanization and naval building have thrown out of date all strategic alloy-metal estimates. The manufacture of armor plate and the making of armored land craft for the Army, of course, would take more than the available supplies of manganese, chromium, tungsten, and other essentials. Hence any export of machinery or materials including these elements is unwelcome to the preparedness planners. The only such exports that will be encouraged are those for emergency aid to Britain. And even those movements are to be offset, if possible, by arrangements permitting prompt movement of ores from British mining sources into the United States. It is likely that if movement of tin or tin concentrates from the Far East is not greatly accelerated, there may be necessity for cutting off the use of tin containers wherever some substitute container material can be developed. The Dutch recently announced a new policy regarding supplies from Netherland Indies and it is understood that huge shipments are being rushed into the United States, as much to protect the supplies of materials for Dutch ownership as for any aid to Uncle Sam. It is of interest to note also that quick action of some of the preparedness groups enabled the United States to get two or three boatloads of chromium ore out of the Eastern Mediterranean even after Italian entry into hostilities.

Few take time now to consider the long-range significance of the tin situation. There is great likelihood that lacquer and enamel coatings for containers will be developed successfully because of the threatened tin shortage. This, many believe, may permanently replace tin in many of the major container fields such as those for lubricating oil, foodstuffs, and industrial materials. The talk about silver as a tin substitute is enthusiastic by a few; but the relative cost makes this an emergency substitution, rather than a probable permanent commercial change, neutral observers conclude.

Congress Continues

IN RESPONSE to general public demand, the plan for adjournment of Congress has, of course, been changed. This means that between recesses there will be an aggressive effort to advance certain legislation which otherwise would have had no further consideration during 1940. Even some of the Wage-Hour and NLRB reforms wanted by business may be taken up.

The President is opposed to the breaking down of the basic principles of either act. But the demand from back home to eliminate red tape and secure a more cooperative official attitude under emergency conditions is having its effect. It will not be surprising if some of the more important changes discussed seriously during the early spring will be enacted during the fall or early winter. It is not likely, however, that even a war emergency will throw overboard the principle of higher over-time pay for long-hour workers or completely eliminate the principle of compulsory collective bargaining by employers. Those two principles seem firmly rooted in federal law.

The continued activity of Congress will, of course, give some chance for the pressing of additional reform legislation, especially such bills as those advocated vigorously by Mr. Ickes dealing with mine safety inspections and control of mineral fuels. However, Congress is not disposed to place new burdens on the mining industry just now, unless some very persuasive evidence of serious conditions is developed.

News "Fines"

Research Groups Move — The metallurgical division of the Bureau of Mines and practically all of the research men doing related work have transferred from Washington, D. C., to Salt Lake City. There they will make up the largest technical unit in the new research building of the Bureau.

Effective in June the research group formerly stationed at the National Bureau of Standards for the American Silver Producers' Research Project has been transferred elsewhere. A number of the staff are now engaged in the laboratory of Handy & Harman, Bridgeport, Conn. Only the fellowship at Lehigh University has been continued elsewhere, and it will be in close cooperation with the Bridgeport effort.

NEVADA

Large Flotation Plant Projected Near Pioche

Combined Metals Reduction Company plans immediate construction of 450 ton mill—Shaft sinking started at Belmont-Phoenix Mine

▶ Announcement was made early in July by E. H. Snyder, vice-president and general manager of the Combined Metals Reduction Company, Stockton, Utah, that construction will start immediately of a 450-ton flotation plant to treat lead-zinc ores mined near Pioche, Nev. Estimated cost of construction is $500,000. The Union Pacific Railroad will extend a spur from the Prince Consolidated mining property to the Castleton shaft of Combined Metals. The company will also increase capacity of its mill at Bauer, Utah, from 17,000 to 20,000 tons monthly.

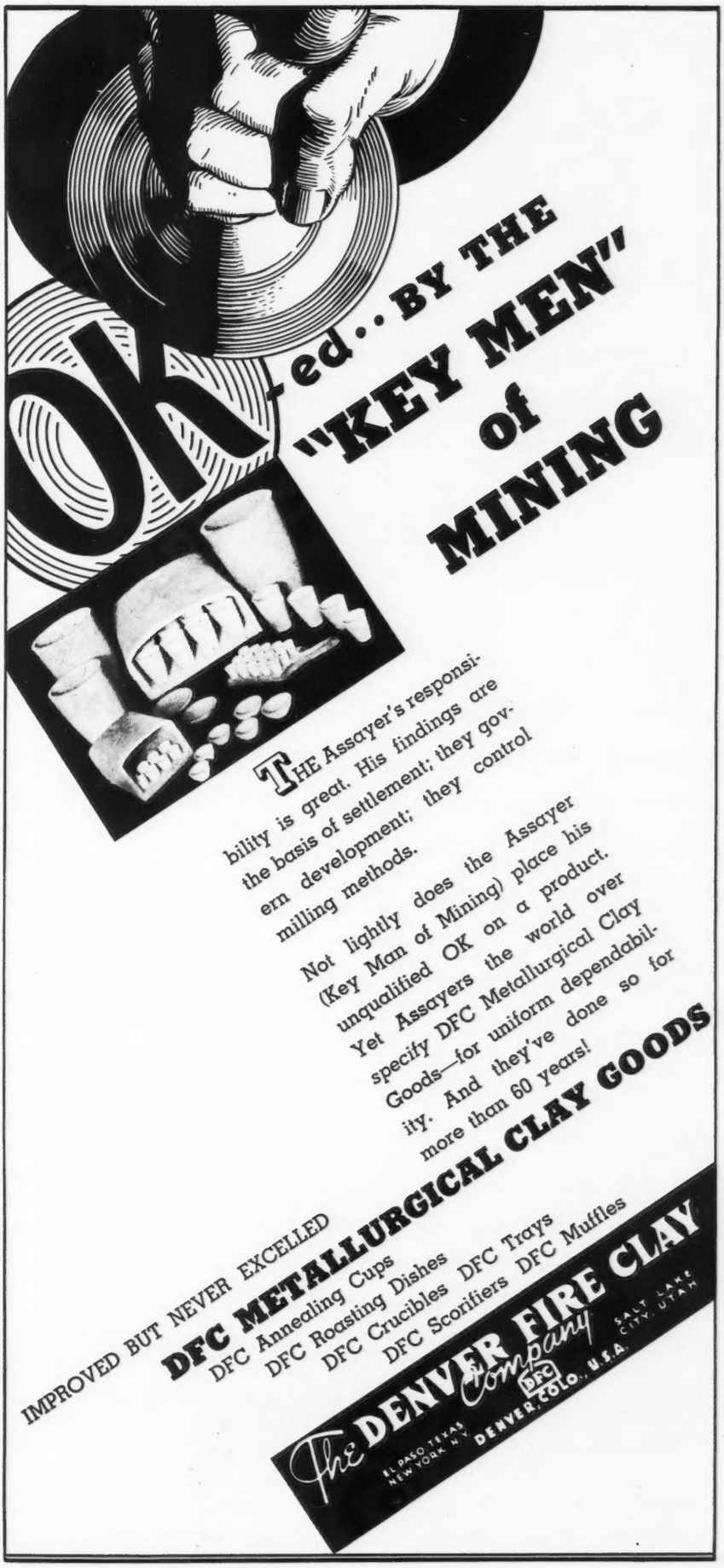
▶ Tonopah Belmont Development Company has started shaft sinking at the Belmont-Phoenix mine, 4 miles southwest of Nelson, Clark County. The property, formerly known as the Oro Plata, is under lease and option to the company from the owners, H. M. Morse and C. E. Wilcox, of Las Vegas, Nev. The gold-silver vein four feet wide is traceable on the surface for 1,500 ft. and is developed by several short shafts and tunnels. Drifting from a shaft 99 ft. deep has developed ore, from which several cars have been shipped to the Garfield smelter in Utah. John L. Dynan is superintendent.

▶ Options on a number of molybdenum claims in Alum Gulch, southern Esmeralda County, were relinquished lately by the Freeport Sulphur Company, which has established a base office in the Gazette Building, Reno, from which an engineering staff is investigating Nevada rare-metal deposits. Arnold A. Gustafson is in charge as chief engineer, assisted by Ralph Taylor and David LeCount Evans, geologists.

▶ Reputed to be a step toward mill financing, engineers will proceed at once to map the geology of extensive property of the Giant Jumbo Mining Corporation near Copper Basin, south of Battle Mountain in Lander County. Stanley F. O'Leary, directing engineer for the company, has arrived at his Battle Mountain headquarters from Holyoke, Mass., where he has spent several months.

▶ Having acquired under option the widely known McCormick-Dermody cinnabar property on the crest of Buckskin Mountain, in northern Humboldt County, the lately organized Buckskin Quicksilver Corporation, composed of California men and with offices at Winnemucca, is providing equipment said to include a 100-ton Gould-type rotary furnace. The deposit is of great magnitude and has been reported to be low grade, but new prospect work is said to have opened orebodies of high furnace grade.

▶ The Gold Point Currant Creek Mines Company has been formed as a consolidation of the Comstock Gold Point Mines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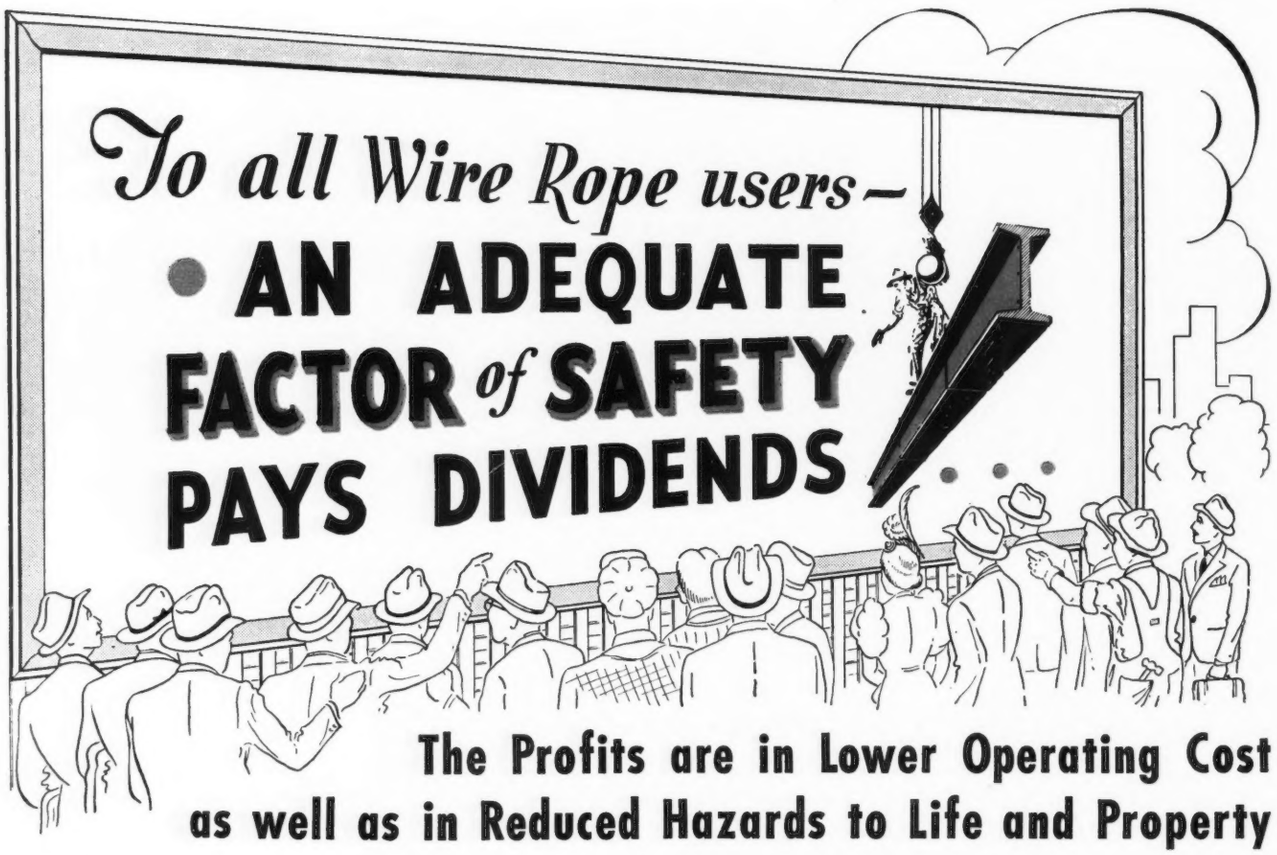

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▶NEVADA

Company and the Currant Creek Mining Company, both under the same control and both during recent months developing gold properties in the Currant Creek district in northeastern Nye County. Trucks have hauled some 500 tons of ore from the claims to the McGill smelter and plans are in process for mill construction.

▶ At the Mountain View gold property, 19 miles northwest of Gerlach, in Washoe County, a large volume of high-grade mill ore is said to have been developed by the Burm-Ball Mining Company, which has an option on the mine, has shipped some 40 carloads of smelting ore, and has completed over 7,000 ft. of drill holes, using two prospecting drills. Managers claim to have blocked 100,000 tons of $14 to $20 gold ore. John Burmeister, with offices at Auburn, Calif., is manager and executive head of the company.

▶ Gold Creek Placers, Inc., a Utah corporation, plans to install a dredge on its Gold Creek property, 75 miles north of Elko, Nevada, announced recently Frank McGregor, president, Atlas Building, Salt Lake City. Tests are being made now. The dredge and dragline will be ready for operations in August or September. The company has completed a 13.5 mile canal from Martin creek to a reservoir having a capacity of 7,000-acre feet. The dredge, it is planned, will be of the floating type, Bodison jig-equipped, with a three-yard drag line and a capacity of 5,000 cu. yards daily.

UTAH

Court Ruling Threatens Leasing Operations

Utah State Supreme Court holds lessee is an employee of company and subject to unemployment compensation — Elton Tunnel expected to be completed in June, 1941

▶ A discontinuance of all leasing operations in Utah affecting the employment of about 1,000 men is threatened by a recent ruling of the Utah Supreme Court in the case of Hartle versus National Tunnel and Mines Company handed down late in June. The court held that the leasee is an employee of the company from which he obtained his lease and subject to unemployment compensation. The United States Smelting, Refining & Mining Company has not renewed any leases that expired June 30, and leasers on the Tintic Standard and Eureka properties are seeking a solution to their problem. The International Smelting Company has not decided on its policy, according to J. O. Elton, manager.

▶ Completion of the Elton tunnel by the National Tunnel & Mines Company in June, 1941, was predicted by officials at the "Tunnel Days" celebration held at Tooele on June 21 and 22. Passage of the 15,000-ft. mark on June 15 was reported by J. F. Dugan, general superintendent of mines for the International Smelting & Refining Company. A total of 1,093 ft. tunnel was built during the month preceding June 15, A. W. Filion, tunnel superintendent, reported. A crew of 77 men is employed in driving the 24,300-ft. tunnel to the Utah Apex mine, in Bingham. About 4,500 gal. of water per minute have been developed for irrigation purposes in Tooele Valley.

▶ D. D. Moffat, vice-president and general manager of the Utah Copper Company, has appointed the program committee for the Western Regional meeting of the American Institute of Mining and Metallurgical Engineers to be held in Salt Lake City on Sept. 10-13. Mr. Moffat, who is general chairman of the committee, appointed W. J. O'Conner, assistant general chairman. Other members are J. O. Elton, F. S. Mulock, M. D. Paine, James Ivers, Gloyd M. Wiles, E. W. Englemann, and James W. Wade.

▶ Lead ore, of good grade, was struck recently in the Milford Lilly property of the Little May Mining Company, in the Star mining district, 5 miles west of Milford, Beaver County, reports Manager John Matson.

▶ Resumption of operations at the Alta Tunnel & Transportation Company property in Big Cottonwood Canyon is planned. A crew has started cleaning out the tunnel. The company was recently reorganized with Raymond C. Wilson as president; F. V. Bodfish, vice-president; Dean F. Brayton, treasurer; H. Christensen, secretary; and D. H. Gove, manager, at Alta, Utah.

▶ The Kearsarge mine, Dry Canyon, Ophir, is to be developed by the Ophir Treasure Mining Company. T. H. Murch, of Beverly Hills, Calif., is to spend $75,000 in return for a half interest in the property, Alonzo Mackey, secretary-treasurer of the company, Atlas Building, Salt Lake City, reports. Charles O. Parker, of Denver, has been engaged to direct the sinking of a 1,000-ft. vertical shaft to the Madison limestone.

▶ Operations have been started again at the Wasatch Gold Mines, Inc., Big Cottonwood Canyon. D. M. Peck, of Salt Lake City, has a contract for advancing the tunnel, now 1,420 ft. long. About 1,600 ft. of driving remain before the company will enter the objective Silver King vein, reports C. S. Woodward, president and general manager, Beneficial Life Building, Salt Lake City.

▶ Tintic Ophir Mines Company has decided to rebuild its plant destroyed by fire recently in the Ophir district. Operations were resumed early in July. F. E. Porter is general manager, Newhouse Building, Salt Lake City.

▶ Operation of the New Park mine, in the East Park City district, yielded a profit of $24,830 in May, according to W. H. H. Cranmer, president and general manager, Keetley, Utah. This brings the total net income to $99,816 before depletion and federal income tax. The oreshoot has been opened for a length of more than 750 ft., reported Mr. Cranmer. Directors of the company were re-elected at the annual stockholders' meeting held at the Hotel Utah, Salt Lake City. Development of an outcrop on the Gold Queen claim is being carried on.

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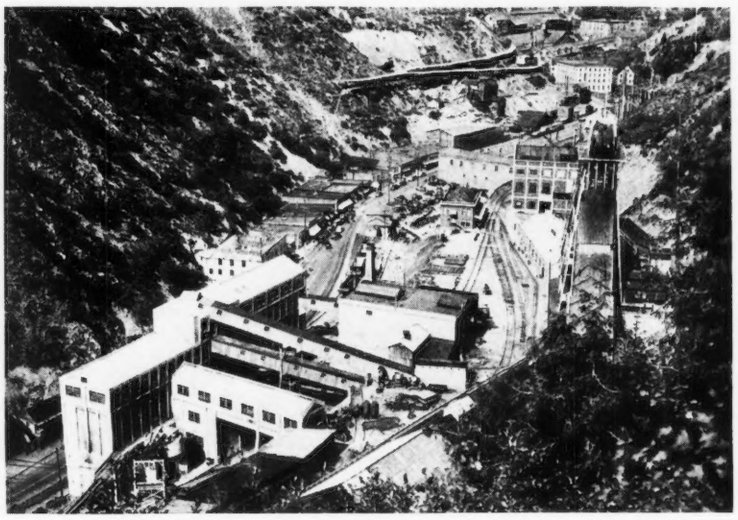


The business district of Burke, Idaho, is not far removed from the mine of the Hecla Mining Company. The headframe is visible on the right and on the left is the mill where the lead zinc ore is treated.

IDAHO

Electrolytic Zinc Plant Operating at Capacity

Production by Sullivan Mining Company estimated at 100 tons refined zinc daily—Bunker Hill & Sullivan installs solarium

▶ The Sullivan Mining Company's electrolytic zinc plant, at Kellogg, is now running at full capacity with a crew of 325 men, according to Wallace Woolf, superintendent. Production is estimated at 100 tons of refined zinc daily. Most of the zinc ore comes from the company's own mine, the Star, situated between Burke and Mullan.

▶ Bunker Hill & Sullivan, at Kellogg, recently completed installation of a new solarium for artificial sunshine treatment of its employes at the Bunker Hill smelter. A similar plant has been in operation at the mine for several years.

▶ Callahan Consolidated Mines, Inc., Nine Mile district near Wallace, is reported to have opened the Rex vein on the Red Monarch tunnel level, according to Joe Grismer, Wallace, contractor.

▶ England Brothers, of Boise, dredge operators, have leased the Independence placers at Moose City from the Independence Placer Mining Company. The ground consists of 400 acres of gravel testing approximately 75c a yard.

▶ Hope Silver-Lead Mining Company, operating at Clarks Fork, is aiming at production of 100 tons daily by the middle of July, according to Albert M. Nash, of Clarks Fork, manager. The ore is coming from the No. 5, 6, and 7 levels. Shaft sinking will be continued to open two more levels.

▶ Lincoln Mining Company has elected Percy J. Power, of Detroit, Mich., as president; Clarence J. Hamilton, of Detroit, vice-president and manager; Toimi J. Lehtola, of Kellogg, secretary; Ted Wellman and Franklin Pfirman, of Wallace, directors.

▶ The shaft at the Silver Dollar, in the silver belt, is now at the 2,300 ft. level, where a station is being cut. Objective is the 2,500 level. The mine is producing 1,200 tons of ore a month, concentrates giving net smelter returns of about 523 oz. silver, 12 per cent copper, and $8 to $10 in gold per ton. About 30 men are employed. C. O. Dunlop, of Spokane, is president-manager.

▶ Hecla Mining Company reported net profits of $175,193.93 for the first quarter of 1940, according to Leo J. Hoban, secretary.

▶ Vipont mine, near Oakley, shipped 100 tons of ore to the Garfield, Utah smelter during the past six weeks. The property is under lease to Leo Duquette, of Oakley, who plans construction of a milling plant in the near future.

▶ Blue Dog property, near Weiser, has added flotation equipment to a small milling plant designed originally to recover gold values by amalgamation. Cecil S. and C. M. Woods, and R. A. Griffiths, all of Weiser, are operating the mine.

▶ Minnie Moore Mining Company, at Bellevue, has opened a vein of commercial lead-silver ore on the 1,200-ft. level. Irvin E. Rockwell, of Bellevue, is president and general manager.

▶ Leasers at the St. Elmo property, in the Coeur d'Alene silver belt, have shipped 77 tons of tetrahedrite silver-copper ore to the Crescent mill, on Moon Gulch, which concentrated into 4.24 tons, showing smelter returns of $197.25 per ton.

▶ Northwest Goldfields Company is building the most modern gold dredge in the United States for operation on the Engineers Gold property near Harvard, according to W. A. Clark, secretary. The dredge is said to cost $200,000 and is equipped with diesel engines with steam-heated quarters for operators.

COLORADO

Selective Flotation Planned by Veta Mines, Inc.

Zinc will be recovered and concentrate shipped to Amarillo, Tex.—Carlton Tunnel, advanced more than half way, is six months ahead of schedule

▶ Robert H. Sayre, president and general manager of the Veta Mines, Inc., at Telluride, is making plans for installation of selective flotation equipment that he might save the zinc in addition to the gold, silver, and lead now recovered. The zinc will be shipped to a smelter at Amarillo, Tex., for treatment.

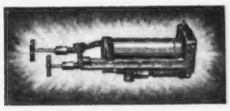
▶ The Cripple Creek drainage tunnel is now over half completed, and the flow of water encountered has receded to a nominal amount. Three factors have contributed to the many records broken in driving this tunnel, which is already over half a year ahead of schedules. These factors are: organization; use of latest modern mechanized equipment; and a bonus system which makes for the highest paid tunnel men in the world. At the face of the bore, holes are drilled by automatic feed drifters equipped with steel centralizers and mounted on a jumbo designed and built in the Cresson shops. The monthly progress follows:

July 1939	345 feet	Timbered
August 1939	1,201 feet	Rock section
September 1939	1,367 feet	Rock section
October 1939	1,534 feet	Rock section
November 1939	1,474 feet	Rock section
December 1939	1,387 feet	Rock section
January 1940	1,438 feet	Rock section
February 1940	1,518 feet	Rock section
March 1940	1,735 feet	Rock section
April 1940	1,696 feet	Rock section
May 1940	1,604 feet	Rock section

▶ Operations have been started by the Molybdenum Corporation of America on the Urad property, in the Daly mining district, eleven miles above Empire. The ore occurring in veins is mined through tunnels and an open pit. The work is being outlined by C. Q. Schlereth and O. R. Whitaker, of Denver, and the 3,500-ft. tunnel is being cleaned out. This property adjoins the United States Molybdenum Company property.

▶ Four miles north of Boulder at Degge's Lake, the Cobalt Mining Company is making plans to erect a smelter to treat copper, nickel, and cobalt ores. This property, known as the Copper King, has been in process of development since September, 1930. Proving and blocking out of ore has been carried on since that time, yet no ore has been shipped. The company purchased a smelter at Pearl, which it is dismantling and moving to the new location. According to the company the smelter will produce nickel, cobalt, copper matte, which will be shipped to the east for refinement.

▶ The Dorothy, Katie and Princess groups of tungsten claims in Boulder have been taken over by the Mining Company of Colorado, Inc., a subsidiary of The Continental Mining Corporation, 80 Broad St., New York, N. Y. The company recently enlarged its mill to 40 tons per day. George H. Teal, of Boulder, is general manager.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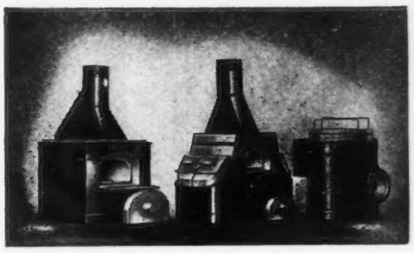
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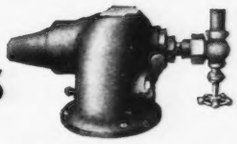
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This hydro-electric power plant on the Pend Oreille River, near Metaline Falls, Wash., will furnish power for increased zinc mining operations during the third quarter, in northeast Washington.

WASHINGTON

Operations Scheduled to Start in Metaline District

Grandview Mines Company preparing to treat zinc-lead ores from property of Metaline Mining & Leasing Company

▶ Metaline Mining & Leasing Company and the Grandview Mines Company are preparing for development and production at their zinc-lead properties in the Metaline district. Operations are planned to start at the end of the third quarter. Work has been in progress for several months at both properties, the former on the west side of the Pend Oreille River and Grandview on the east side. Ore from both properties will be milled at the Grandview mill, which has been improved and enlarged to handle about 400 tons per day.

▶ Jupiter Lead Company, which owns the Last Chance mine, near Northport, has leased its lead-zinc holdings to Firmer Walkley, of Northport, and Dr. Tedford Moore, of Spokane, who are putting up a 25-ton mill.

▶ Washington Miners' and Prospectors' Association, with headquarters at Grand Coulee, Wash., is supporting an enterprise for the construction of a smelter three miles above the Grand Coulee dam. Coulee Dam Smelting Company has been organized for the purpose. Jess Lewis, A. F. Rawe, and A. P. Knox are trustees of the company. When $75,000 has been raised at Grand Coulee and in that vicinity, it is said Electric Furnace Corporation, of New York and Denver, has agreed to install furnace equipment to the amount of $50,000, taking stock as payment.

▶ Northern Cascade Mines, Inc., formerly the Gold Hill Operating Company, has leased its gold-silver property to Seattle and Spokane men, who have put a crew into the lower tunnel and additional men onto the highway to improve transportation. The company's holdings consist of 38 claims adjoining the Azurite mine.

▶ Northwest Magnesite Company, at Chewelah, has greatly increased its production in the last few weeks and has increased its payroll from 300 to 425 men. The government is urging the company to enlarge its plant materially, which officials say can be done only at great expense.

OREGON

Several Mineral Areas Being Mapped

State Department of Geology and Mineral Industries conducting surveys — Cougar-Independence mine resumes operations

▶ Oregon State Department of Geology and Mineral Industries and Oregon State College will map the quadrangle east of the Riddle quadrangle this summer with Dr. W. D. Wilkinson in charge. The district known as the Butte Falls quadrangle, contains several quicksilver and other deposits. The work will be supplemented by John Eliot Allen and Wayne Lowell. Another party is mapping the Grants Pass quadrangle with Dr. Francis G. Wells in charge.

▶ The Cougar-Independence property, after a brief shutdown, has resumed operation, producing 10 tons of concentrates a day from 80 tons of ore. The property is at Granite, Oregon. Ben O'Frary is superintendent. About 50 men are employed.

▶ Leverett Davis, mining engineer, who formerly was in charge of the Cornucopia mine, and more recently has taken over

on his own account, the adjacent Simmons mine, may install an aerial tramway to lower the ore already blocked out down the mountain for treatment in the mill of the Cornucopia Gold Mines Company.

▶ Control of Argonaut Gold, Inc., has been acquired by H. C. Wilmot, who is developing ore on the hanging-wall side of a vein, which has been drifted upon for more than 100 ft. The property is 13 miles north of Sumpter. A gold strike was reported from this property in February.

ALASKA

Tin Deposits Being Thoroughly Investigated

United States Geological Survey conducting a four-year survey to determine domestic resources of this strategic mineral —Echo Cove Mining Company starts development program

▶ Dr. J. B. Mertie, of the United States Geological Survey, is conducting a four year survey for tin deposits in Alaska. The extreme western part of the Seward Peninsula has been investigated, and his party will prospect in the regions of the Brooks and York Mountains and examine a prospect in the Lost River area. Alaskan concentrates contain a high percentage of tin per ton and past production of tin in Alaska exceeds that of all other domestic districts combined. There are extensive tin-bearing gravels in the Territory, and it, therefore, presents the best opportunity for more thorough investigations.

▶ The Golden Zone mine, north of Anchorage, expects milling operations to get under way within a few weeks, according to Henry Stevens, of Broad Pass district. The company expects to speed operations by working three shifts. From the main 1,500-ft. tunnel, a raise of about 350 ft. to the surface is planned for ventilation. The large hydro-electric plant which is to supply the mill with power is about ready for operation.

▶ Echo Cove Mining Company will launch its first large-scale work of its development program on its property, north of Eagle River, when it barges materials to the cove for building a 1½-mile road. About three weeks will be spent building the road from tidewater to the property on Davies Creek, and a mill site will be surveyed. Robert Boyd is superintendent and engineer. Incorporators and directors of the company are R. M. Shephard, C. D. Beale, J. C. Cooper, H. G. Watson, N. C. Banfield, E. P. Pond, and H. L. Faulkner, all of Juneau.

▶ L. A. Levensaler, mining engineer of Seattle, was elected president of the Cliff, Valdez's famous old bullion producer, at a recent meeting of directors and shareholders. He decided on immediate action at the property, which had been shut down for several months. Charles Simenstad, with a crew of about a dozen men, is now at the property, developing the rich orebody that has been mined on the 400- and 500-ft. levels.

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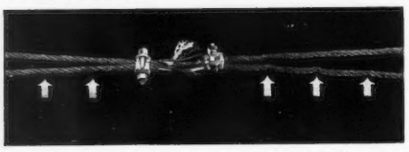

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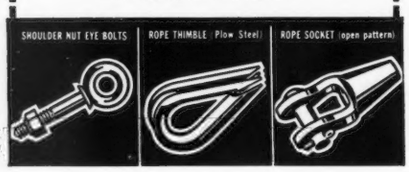


TRI-STATE

Activity Increases at Many Zinc Mines

Higher prices for concentrates bring wage increase to workers—Small operators encouraged to resume operations

▶ Following the advent of the 6¼c. slab zinc price, which brought the Eagle-Picher custom milling settlement on zinc concentrates to $41.00 a ton, the company subsequently announced a 50c. increase in the wage scale of nearly 1,500 mine and mill employes. The increase brought the base pay of machine men to $5.05 a day, machine helpers to $4.55, and wages of other employes were increased accordingly. Wages are in keeping with a sliding scale based on a 50c. increase, or decrease, for every $5-a-ton fluctuation in the zinc concentrate price, starting at $4.05 for machine men with the blende price ranging from $30 to $35 a ton. Nearly all other companies operating in the field maintain a similar scale, which is based on a 25c. fluctuation in the daily wage with each $2.50-a-ton revision in the open market price of zinc concentrate, which, when the ore price passed the $40-a-ton mark, resulted in a 25c. increase in the daily wages of their employes.

▶ Lula Bell Mining Company has reopened the old Standard field shaft, a mile north of Cardin, according to Charles Barnett, of Joplin, president of the company.

▶ Federal Mining & Smelting Company resumed operations on June 10 at its Muncie mines and mill, northwest of Treece, according to L. C. Johnson, district superintendent of the company. Approximately 50 men were reemployed.

▶ Mission Mining & Royalty Company has reopened the old A shaft on the Weiss land, north of Quapaw, according to J. C. Heilman, of Baxter Springs, company superintendent.

▶ The Owl Royalty Company has reopened the north field shaft on the old Malsbury lease of the Century Zinc Company, south of Baxter Springs, in Oklahoma. The Malsbury was one of the richest producers of zinc and lead ore in the Tri-State district, and was last operated in 1927. C. W. Ritter, of Joplin, is in charge of ground operations.

▶ With the resumption of mine operations by the Davis-Big Chief Company on the old Commerce Pelican lease, the Eagle-Picher Company has placed its Bird Dog central mill in operation on a part-time schedule.

▶ Secretary of Labor Frances Perkins on April 23 conducted in Joplin a conference on health, living, and working conditions in the Tri-State mining field. The conference was attended by approximately 300 representatives of mine operators and mine unions, State health and labor officials, and federal experts. As a result of the conference the secretary held that "a problem exists" in the district and asserted that the principal solution lies in uniform regulatory methods by the three states concerned—Oklahoma, Kansas, and Missouri. She announced at the conclusion of the conference that she would appoint in the near future a committee of representatives of the three states to explore the possibilities of perfecting a "state compact agreement" for coordinating the work of concerned authorities and agencies. Announcement of that committee has not been made as yet. During the tour, she stopped at the Ballard mine of the St. Louis Smelting & Refining Company near Baxter Springs and went underground to make a first-hand inspection of working conditions.

▶ In the Missouri section of the Tri-State, Eagle-Picher Mining & Smelting Company has completed a new shaft to the 211-ft. level on the old Navy Bean lease, 4 miles west of Wentworth, and has started drifting toward the northeast to an orebody on the adjoining Reynolds land, which was blocked out by churn drilling by the company about three years ago.

▶ Southeast of Wentworth, the Success Mining Company has started mining and milling operations at the old Blue Bell property on the Kline land, according to F. H. Gartung, of Miami, who is in charge of operations. Between 35 and 40 men are being employed at the property.

IRON COUNTRY

Operators Increase Iron Ore Production

Estimates of shipments this season reach 65,000,000 tons as demand for steel increases for defence purposes

▶ The consumption of iron ore in the Lake Superior district for May is estimated close to 5,000,000 tons. All properties are shipping practically at capacity, and a reappraisal of total shipments from the Lake Superior district is now between 60,000,000 and 65,000,000 tons. The Mahoning Mine of Pickands-Mather has a production schedule of 5,000,000 tons, and several of the independent operators are running between 1,000,000 and 2,000,000 tons at various mines.

▶ The Snyder Mining Company has awarded a contract with S. E. Atkins Company, of Duluth, to conduct drilling operations on a forty near the Shenango mine.

▶ The Blast Furnace Committee of the United States Steel Company, headed by C. D. King, of Pittsburg, visited the Iron Ranges of Minnesota recently, and blast furnace men from every subsidiary of the Steel Corporation were in attendance. They visited the properties of the Steel Corporation and had meetings in regard to the various ores in connection with blast-furnace practice.

▶ All the smaller contractors are busy working on schedules. Those which are quite active are: The E. W. Coons Company, at the Coons Mine, Va.; The Charleson Iron Mining Company, at the Pacific and Judd mines, and the Black Rock Mining Company, at the Alice, Silver and Chandler mines.

U. S. Buying Tin For National Defense

▶ Federal Loan Administrator Jesse H. Jones disclosed at a press conference in Washington on July 1 that two companies had been created, one to acquire 75,000 tons of tin and the other 150,000 tons of rubber to augment stocks of strategic materials for national defense. He mentioned manganese as one of the materials to be stocked, but gave no details of the program for that metal.

The Government had set up the Metals Reserve Company, capital $5,000,000, to acquire the metals, and the Rubber Reserve Company, capital $5,000,000, to stock rubber. The R.F.C. also authorized a loan of $100,000,000 to the metal company and $65,000,000 to the rubber concern.

The Metals Reserve Company already has an agreement with the International Tin Committee to purchase the 75,000 tons of tin, to be held as a reserve, at 50c. a pound, c.i.f. United States ports. The metal is to be acquired in about a year.

Rubber acquisitions will be obtained at prices ranging from 18c. to 20c. a pound, c.i.f. New York.

The program supplements the Treasury Department's purchases undertaken during the last six months, it was announced.

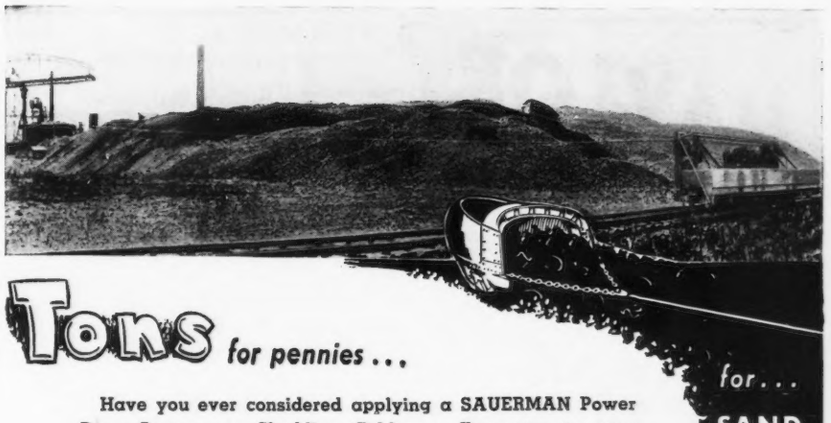
▶ The export quotas of countries participating in the control of tin production have been raised from 100 per cent of standard tonnages to 130 per cent, effective July 1, and the higher rate is to continue for one year. It is reported that many tin dredges and other equipment will be quickly rehabilitated in the Netherlands East Indies and Malaya to produce to capacity.

CANADA

Higher Taxes Imposed On Mining Industry

Established gold and base metal producers are effected, but provision is made for mine expansion without tax penalty

▶ Under the budget that was submitted to Parliament on June 24, increased federal taxation rates are imposed on the old established gold mines and on the base-metal producers. These branches of the Canadian mining industry are now obliged to pay at least two-thirds more than their pre-war assessments, plus 75 per cent of excess profits. For taxation purposes they are grouped with manufacturing, but provincial taxes are in some cases higher than those levied against other industries. In order to encourage increased gold output, the budget favors new mines that have come into production since Jan. 1, 1938, by imposing no corporation tax. Other mines pay a minimum corporation tax of 30 per cent on profits, plus 75 per cent of profits in excess of the average over the four-year period 1936-1939. Provision is also made for mine expansion without tax penalty.



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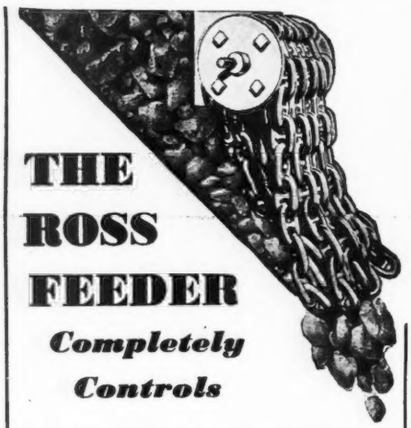

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▶CANADA

British Columbia

▶ Privateer Mine, Ltd., premier gold producer in the Zeballos district of Vancouver Island, has taken an option on 2,580,000 shares of the capital of Proserpine Gold Mines, Ltd. The move is part of a broad plan to extend the profitable life and dividend record of Privateer while production of its Zeballos mine is in full swing. Immediate objective of the arrangement is to supply the Proserpine company with funds for development of its properties in the Cariboo district for a total price of $350,000 net to the company, shares to be delivered in lots of 10,000 units and paid at the rate of 13.6c. per share.

▶ At the annual meeting of Mount Zeballos Gold Mines, Ltd., it was disclosed that from the start of milling on Aug. 15, 1939, to Dec. 31, a net profit of $41,095 was obtained, after write-offs of $11,139. The loan of $128,400, made by Conwest Exploration Company to finance placing the Zeballos company on a production footing, was reduced by $10,000 as at Dec. 31.

▶ In the Cariboo district, Island Mountain Mines Company, according to a report for the three months ended March 31, 1940, produced 11,366 tons of ore valued at $199,993, and in the same months last year recovery was valued at $167,067 from 11,400 tons. Estimated operating profit for the first quarter of this year, before depletion, depreciation, and taxes, was $85,295.

▶ Cariboo Lakes and Placers Company, operating leases in Beaver Pass Valley, recently completed a test clean-up from which more than 300 oz. of placer gold is reported to have been recovered for the three weeks worked by one unit. Another large tractor and bulldozer is expected to arrive at the operations soon, when an additional unit will begin work.

MEXICO

War Halts Metal Shipments to Italy

Stoppage of lead exports as well as other mineral products begins to effect the mining industry—Threatened strike of electrical workers in mining district postponed—Miners' union give strike order.

▶ Mining in Mexico became more confused with the advent of summer, owing largely to the sudden and somewhat unexpected strengthening of the peso, which on June 10 dropped from around the 6-to-1 rate it had maintained since mid-December to 5.25 to 5.35 recently. On the face of it, it would seem that the cheaper dollar would benefit the industry. But some mining men contend that they were just about able to pay expenses at the 6-1 rate, but that with the quotation around 5.35 their monetary difficulties have increased because of high wages and high operating costs. Italy's war plunge has further upset mining in Mexico. It has removed a good market for several metals and minerals, particularly lead, which meant sales for Mexico of around 2,000,000 kilograms a month. Mexico has also lost an excellent customer for oil and its products as a result of Mussolini's decision. However, Mexicans believe all is not dark. Mexico hopes it will be able to sell silver to the United States for a long time and the higher price for that metal is proving beneficial.

▶ Production at the rate of 120 metric tons a day is being maintained by Cia. Minera del Cubo, S.A., at its gold-silver where 297 men are employed.

▶ With both candidates in the recent presidential election claiming victory, there are signs of uneasiness throughout the mining industry. There is an apparent threat of labor trouble at this time, with strike ultimatums effective July 10 against the Cia. Minera Peñoles, and Mexico's largest steel industry, both in Monterey. The union has served notice to the American Smelting & Refining Company that unless there is an agreement to revise its labor contract, now up for renewal, the miners will call a strike July 15. A general strike is also threatened unless the government takes action to settle the strike at the Green Cananea Copper Company, Sonora, which has been in progress of negotiation for settlement since soon after the strike started on April 5. Business in a wide section of Northwest Mexico has been affected by failure of settlement.

▶ Discovery of rich gold-silver deposits at La Puente and on the Santa Fe y Anexas ranch, near Ciudad Ocambo, Tamaulipas, by Victorino Treviño, of Ciudad Mante, Tamaulipas, has been reported to Ministry of National Economy.

▶ Because of an acute lack of raw materials, the Cia. Fundidora Mexicana, S.A., has petitioned the Federal Board of Conciliation and Arbitration for authorization to suspend work at its smelter in Mazapil, Zacatecas. The company says that orebodies which supplied the plant have become exhausted and there is no immediate prospect for obtaining sufficient metal to maintain operation.

▶ The provision of the new general communications law which forbids the shipping by interurban trucks of lead and its concentrates is being strictly enforced by the Ministry of Communications and Public Works. All such shipments must be made by railroad, the law provides. Highway police have strict orders to enforce this measure. The law has created difficulties for the American Smelting & Refining Company and Cia. Compania de Peñoles, which used trucks to a considerable extent to move this metal from Monterrey to Laredo, Texas, for distribution in the United States and for movement to Europe.

▶ Mining in a wide region of Zacatecas and Puebla was spared the embarrassment of a general electric strike, set to start on June 10, when the federal labor department induced the workers to postpone the walkout until Aug. 9. The department hopes that it will be able to settle this conflict by the end of the truce.

AFRICA

Large Bauxite Deposit Developed in Nyasaland

Consideration being given to the establishing of aluminum industry—British mining companies proceeding with expansion programs

▶ After nearly two years of quiet investigation, the Anglo American Corporation of South Africa is able to announce that a bauxite deposit which it has been prospecting contains upwards of 60,000,000 tons which compares favorably in composition with commercial deposits elsewhere in the world. This deposit is in the southeasterly corner of Nyasaland, and occurs at an elevation of 6,000 ft. It has been determined that a substantial volume of hydroelectric power can be developed on the Shire River. The possibility of establishing an aluminum producing industry in Nyasaland is being seriously considered, and an American engineer has been engaged to report on the whole position. The British South Africa Company is associated in the undertaking.

▶ Grootvlei Propriety Mines is expanding its reduction plant to a capacity of 120,000 tons per month, or 1,440,000 tons annually, against 947,500 tons milled last year. The extension is expected to be in operation early next year, and funds in hand are estimated to be sufficient to pay for the construction and equipment.

▶ The copper produced by Union Miniére du Haut-Katanga, which hitherto has gone largely to Germany through Belgium, is expected to be secured now by the British for allied war uses. Germany has occupied Belgium, but not the Belgian Congo. Whether Germany will attempt to gain control of the latter by dropping parachute troops, in order to secure the Belgian Congo's considerable production of gold, tin, and cobalt, and to obtain copper from there by air transport, is a matter now receiving attention. As Germany's domination of Belgium virtually makes Belgium and the Belgian Congo enemy countries, Britain and the Belgian Congo could send troops to protect the mining interests, without any violation of international law. It is considered likely that this will be done.

▶ British-controlled mining companies in all the Dominions and Colonies are going ahead with their activities and expansion programs in full confidence that the war will be won.

▶ Two statements made at the annual meeting of Western Holdings have news value. One was that the company, together with Union Corporation, which is associated in its undertaking, has secured what is believed to be the whole of the gold-bearing area in the Orange Free State. The other was that drilling in the southern area is practically completed, the results justifying shaft sinking. It was also declared that recent drilling had disclosed further payable reefs which confirm earlier confidence.

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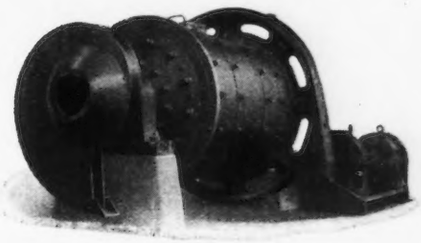

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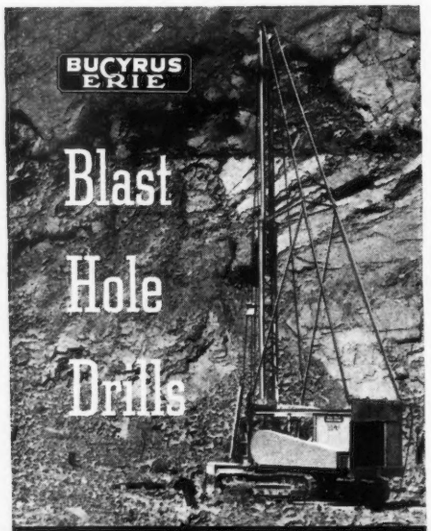

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INDIA

Champion Reef Gold Mines Adopts Air-Conditioning

Nundydroog Mines, Ltd., will also install plant to cool air as mining operations become deeper — Extensive shaft-sinking program also planned

▶ The Champion Reef Gold Mines of India, Ltd., produced 69,058 oz. of gold from 161,220 tons of ore milled and treated in 1939. The average assay value of the ore milled was 8.72 dwt. of gold per ton, and the extraction represented 98.23 per cent of the gold content. The aggregate of the working costs, compared with the figures for the previous year, shows an increase of £20,062 2s. 5d., due mainly to the higher cost of ventilation during the hot season and an increase in the amount of work on support of ground in the mine. The cost per ton milled, excluding development, was 30s. 10d., or 2s. 7½d. per ton higher than in 1938. The outlay on capital account amounted to £94,086 10s. 2d. This includes the cost of new hoist for the Gifford shaft, the Heathcote shaft and the South Main Winze, and also shaft equipment, in accordance with the scheme of lay-out of the mine to depth. In view of the increase in temperature concurrent with the deepening of the mine, an air-conditioning plant is being erected at surface for cooling the air passing into the lower levels, and should be in operation within the third quarter. H. M. White is superintendent, with offices at Kolar Gold Field, Mysore State, Southern India.

▶ Nundydroog Mines, Ltd., in 1939, treated 242,600 tons of ore and produced 87,271 oz. of gold; 131,091 tons of accumulated tailings were re-treated, yielding 5,353 oz., making a total of 92,624 oz. of gold, as compared with a total production of 99,751 oz. for 1938. The average assay value of the ore milled was 7.31 dwt. per ton with a recovery of 98.04 per cent. Ore reserves at Dec. 31 last were estimated at 516,593 tons, or an average value of 11.19 dwt. per ton. The auxiliary shafts are reaching their designed depth of 3,000 ft. For continuing the development and working of the mine in depth, the company will sink one new sub-vertical shaft and three new auxiliary shafts, and necessary underground preparations, are now under way. An air-conditioning plant will be installed to improve the working conditions in the deeper levels. R. C. K. Morrison is superintendent, with office at Oorgaum, Mysore, India.

▶ During 1939, 99,127 oz. of gold were produced from 236,617 tons of ore by the Mysore Gold Mining Company, India. The average assay of the ore was 8.55 dwt. of gold per ton, and extraction represented 98.02 per cent of the gold content. South of north auxiliary vertical shaft, at the 90th level, a run of ore has been opened up for a distance of 149 ft., 1 ft. 3 in. in width, assaying 1 oz. 8.3 dwt. per ton. The reclamation of ore isolated by rock-bursts was successfully continued, and a large tonnage is now being produced from these areas. The reserves of ore at Dec. 31 last were estimated at 459,000 tons of an average grade of 10.8 dwt. This shows an increase during the year of 6,000 tons and a decrease of 0.6 dwt. in grade. John Taylor & Sons are managers for the property and C. B. Taylor, is superintendent at Mori Kuppam, Mysore, India.

▶ The Ooregum Gold Mining Company of India, Ltd., produced 53,710 oz. of gold from 161,350 tons of ore milled and treated in 1939, with 112 oz. recovered from residues, and 13 oz. were obtained from 92 tons of ore milled for this company by the Nundydroog Company, making the total return of fine gold 53,835 oz. The average value of the ore milled was 6.81 dwt. per ton, and the extraction represented 97.75 per cent of the gold content. The air-conditioning plant was in continuous operation throughout the year and maintained excellent working conditions underground. As a result, a higher rate of development was accomplished, which resulted in substantial additions to the ore reserves. G. Benn White is in charge of operation at the mines, at Oorgoum, Mysore, India.

AUSTRALIA

Mining Operations Continue on Steady Basis

Gold and base-metal production set for greater output—All surplus of tungsten being taken by Government

▶ Arrangements have been made for the United Kingdom Government to purchase Australia's exportable surplus of wolfram and scheelite at a price of 50 shillings sterling per unit f.o.b. Production is about 1,000 tons of wolfram and 250 tons of scheelite annually, all of which has hitherto been exported.

Western Australia

▶ Figures from the annual report of the Chamber of Mines of Western Australia for 1939 make interesting reading. Of the total output of 1,214,237 oz., some 968,000 oz., or 80 per cent, came from the operations of 36 companies, which are listed, and some of which produced as little as 2,000 oz. The number of small producers, prospectors and others, must be large. These 36 companies treated 3,730,000 tons of ore, the average recovery being 5.19 dwt. per ton, with a range from 3 oz. per ton to 2.36 dwt. Kalgoorlie mines averaged around 6 dwt., Wiluna 3.10, and Big Bell 2.66 dwt. The 36 mines employed 8,119 men, showing an average output of 459 tons per man. Kalgoorlie mines were close to the average, whereas the medium-size mines outside Kalgoorlie averaged around 350 tons per man, and Wiluna handled 750 and Big Bell 1,113 tons.

▶ The Broken Hill Proprietary Company, Ltd., which operates the most northerly mine on the field, the Hannan's North, has taken up two 24-acre leases to the north of the present workings. This step

is interesting as indicating a possible extension of the Kalgoorlie lode channels to the north.

▶ Triton Gold Mines, N. L., which is testing the adjoining Rand leases of Western Gold Mines, N. L., under a co-operative arrangement, reports that diamond drillhole No. 78, designed to test the lode at depth, intersected the lode at 1,088 ft. The mine is a difficult one to work on account of the crushed and contorted nature of the walls, necessitating considerable timbering and the keeping of filling well up to the backs.

Victoria

▶ Morning Star (G.M.A.) Mines N. L., Woods Point, has taken an option over the Loch Fyne mine, at Matlock, nearby. The ore occurs in veins in a diorite dike, and has been worked by previous holders to a depth of 700 ft. It is intended to test the dike below this depth by diamond drilling.

▶ Central Nell Gwynne Gold Mining Company, N. L., Bendigo, recorded its best profit yet for the half year to March 31, £A39,912, derived from the treatment of 14,863 tons of ore which yielded 6,147 oz. of gold as bullion and also about 160 oz. in pyritic concentrates. Working costs were 24s. 1d. per ton. The company is in a satisfactory position, with quartz proved to a depth of 1,400 ft., although stoping has as yet extended to a depth of 1,080 ft. only.

New South Wales

▶ Lake George Mines, Ltd., Captain's Flat, increased output during the quarter to Dec. 31 last. Operating expenses amounted to £69,993. Development work for the quarter totalled 1,409 ft. It is reported that during the quarter one shipment of 2,364 long tons of lead concentrate was made to Belgium, and another of 1,884 long tons to U.S.A., and excess stocks were expected to be cleaned up by the present time. A satisfactory trial has been made of Lake George pyritic concentrate as a source of sulphur for fertilizer manufacture, and arrangements have been made for the supply of a larger tonnage.

Queensland

▶ The Mount Miller manganese mine, at Mount Miller, 7 miles from Gladstone, has been taken up by the Broken Hill Proprietary Company. The ore runs around 75 per cent MnO_2, but the bodies vary greatly in strike, dip, and size.

▶ During 1939, Mount Morgan, Ltd., installed a 5 ft. 6 in. Symons cone crusher, a 12,000-ton fine-ore bin, two 5 ft. 6 in. ball mills with classifiers, and a 14-cell flotation unit. Since the close of the year, the remodeling of the "oxide" mill to convert one section for the treatment of sulphide ore has been completed. This work involved the provision of ten Fagergren flotation machines, a thickener, and a concentrate filter. This section, now termed No. 2 sulphide mill, is handling 16,000 tons of sulphides monthly, and the oxide section is putting through about 20,000 tons of oxidized material per month, as well as the granular portion of the No. 1 sulphide mill tailings, amounting to 37,000 to 38,000 tons per month.

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with AKINS CLASSIFIERS

This Classifier Starts WITHOUT UNLOADING

Can you start again, *immediately*, when you want to start? You can if you are using AKINS Classifiers—because the AKINS will always start without unloading. It is never necessary to grind out the circuit before a shutdown. Furthermore, normal circulating sandload and normal density overflow are established immediately. With demand for all metals rapidly increasing, this big gain in operating time means money to you.

Other Advantages—Greater overflow capacity per foot width, with a big saving in floor space; operate at slope of 4" to foot, without backslip or surge; ability to produce extremely fine overflow; efficiency at high density; more tonnage and improved metallurgy at lower power cost.

SEND FOR BULLETIN 24-HA

We also build:
Lowden Dryers; Skinner Multiple Hearth Roasters; Ball, Rod & Tube Mills; Diaphragm Pumps; Smelting Equipment

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MAIN OFFICE DENVER, COLORADO, U.S.A.

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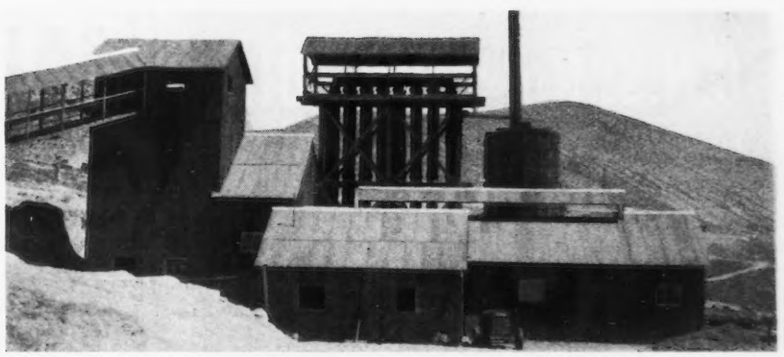
THE CLYDE ENGINEERING CO., LTD., GRANVILLE, N.S.W.
CANADIAN LOCOMOTIVE CO., LTD., KINGSTON, ONT., CAN.
VANCOUVER IRON WORKS, LTD., VANCOUVER, B. C., CAN.
MARSMAN TRADING CORP., MANILA, P. I.



Greenan Quicksilver, Inc., Humboldt Co., Nev.

GOULD ROTARY FURNACE AND CONDENSING SYSTEM

From 5 to 200 Tons daily capacity

THE STANDARD OF QUICKSILVER REDUCTION EQUIPMENT

Each unit of any Gould plant is designed for, and built to, the demand of the job it has to perform. The Gould plant is not a stock job but one which is engineered for each application after individual characteristics of ore and operating conditions have been carefully studied. As operators of several of the largest quicksilver mines in the country, our plants are being constantly tested, improved on, checked and RE-CHECKED!

Let us help you with your plant requirements, let us design your plant—erect it if you wish, and provide a capable operator to get you started: let us provide you with a quicksilver plant which is recognized as standard the world over!

Lowest Costs
Accurate Control
Individually Designed
Greatest Flexibility

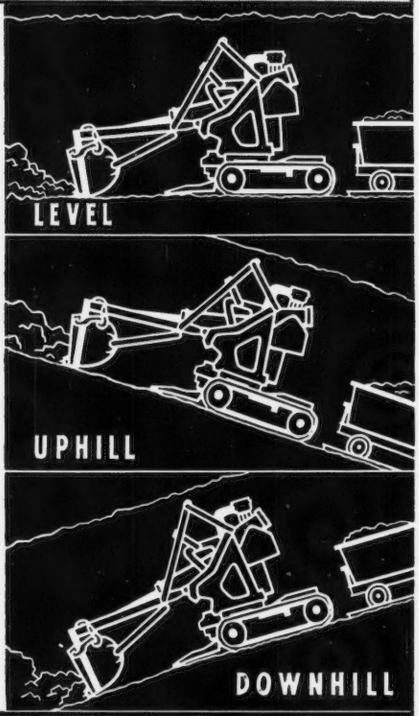
MERCURY
ROTARY FURNACES AND CONDENSING SYSTEMS

H. W. GOULD & CO.
MILLS BUILDING
SAN FRANCISCO, CAL.

Here is a SHOVEL that loads on grades

Mounted on powerful air operated crawlers, this shovel is quickly moved into service. Full-revolving, it loads into cars at the rear or either side.

Grades up to 30% afford no great obstacle to the Nordberg-Butler Crawler Shovel. Being able to load on either uphill or downhill grades, this shovel is adapted to the widely varying conditions so frequently encountered in underground loading. It is not confined to operating in a practically level position.



NORDBERG MFG. CO., Milwaukee, Wis.

NORDBERG-BUTLER UNDERGROUND SHOVEL

G.N.S. No. 5 PINE OIL

LONG THE STANDARD FROTHING OIL

For Flotation

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NEWPORT INDUSTRIES, Inc.
230 Park Avenue New York, N.Y.

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ZINC DUST

Because of its increased efficiency, Merrillite is preferred. A highly refined zinc dust, of extreme fineness and always uniform.

Its source is a guarantee of quality

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Buy pipe by RATING *- not weight*

Spiral Pipe, as made by Taylor Forge, costs about half as much installed as wrought pipe of equal strength.

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Joints, sizes, gauges lengths and coatings for every mining service.

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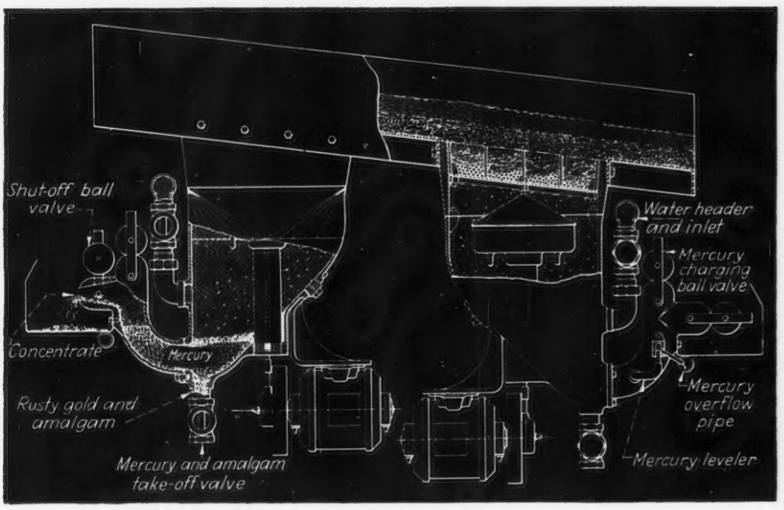
EQUIPMENT NEWS

Gold Concentrator for Dredges



A NEW TYPE of concentrator for the recovery of placer gold as fine as 400 mesh, and intended primarily for use on dredges, is offered by the Peterson Concentrator Company, 470 25th St., Oakland, Calif. The machine differs substantially from the ordinary jig in which a displacement diaphragm applies alternate suction and pulsion strokes to the bed, thereby aiding feed particles of high specific gravity to sink through the bed into the hutch. In the Peterson concentrator the bed is kept open and permeable by the high-frequency vibrations of a diaphraghm mounted inside the hutch adjacent to the screen.

The accompanying drawing shows two of the units bolted to a sluice and receiving the flow from a trommel screen or rougher jig. The bed has cross riffles and a down-stream inclination of 1½ in. per foot. The hutch is round instead of square or rectangular, thus eliminating dead corners and eddy currents. Mounted inside the hutch is a rubber diaphragm that is caused to vibrate more than 2,000 times per minute through an eccentric connection with the drive shaft of a small electric motor. At the bottom of the hutch is a mercury trap. The hydrostatic balance between the water in the hutch and the mercury column is maintained at a point that permits water and concentrate to pass across the mercury and up to a point of discharge. Heavy particles of metal and amalgam sink through the mercury and may be withdrawn through a valve. Clean-up is easily and quickly effected without stopping operations. Where a large volume of low-grade material must be handled at high sluice velocity, primary concentrators are installed ahead of the amalgamating type just described. These primary units are equipped with rubber-lined collapsible throat discharge valves in place of mercury traps. Their concentrates are re-treated in amalgamating type jigs.

These machines are built in three sizes, 6-in., 12-in., and 24-in. Each cell is a self-contained unit with individual motor drive. A 24-in. cell with a capacity of 10 cu.yd. of minus-½ in. material per hour requires only ⅓ hp.

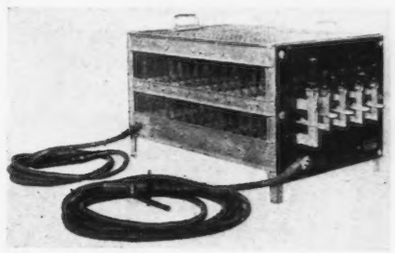
New Type Locomotive

TO MEET the requirements of mine haulage at the Island Mountain Mines Company, Ltd., British Columbia, the Atlas Car & Manufacturing Company, Cleveland, Ohio, designed this 2½-ton Type K storage battery locomotive, a new unit between its 1½- and 3-ton types. The manufacturer points out that the drive is by totally inclosed spur gears running in an oil bath, and with all

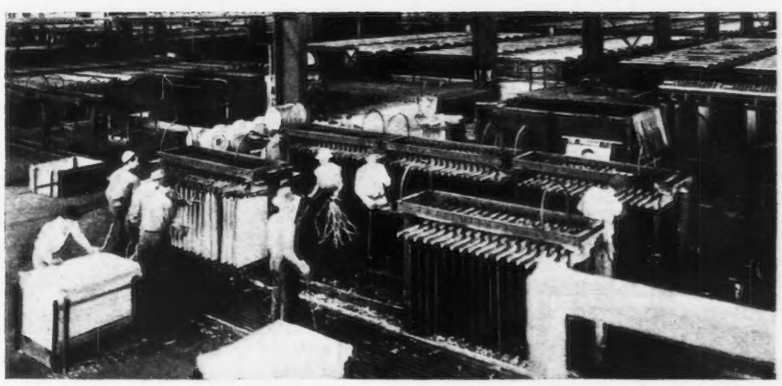
bearings of the anti-friction type, being especially sealed to prevent muck or water entering the bearings. The locomotive is said to be equipped with powerful shoe brakes, mounted in such a way as to be protected from wheel wash and water. The frame is fabricated of structural sections by combination riveting and welding methods, with the bumpers of welded-steel construction.

D-C Arc Welder for Mine Service

GENERAL ELECTRIC Company, Schenectady, N. Y., has announced a new resistor-type, d-c arc welder designed particularly for mine service. Portability and sturdy construction are among



the chief features of this new welder. It is 17 in. high, 20 in. wide, and 30 in. long, and weighs 78 lb. To withstand rough handling successfully, the resistor units are wound in continuous coils with-

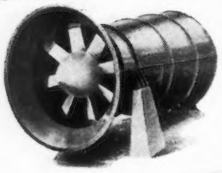


The B. F. Goodrich Company, Akron, Ohio, announces an interesting use of Plastikon rubber putty in the electrolytic tank house of the copper refinery of Phelps Dodge Corporation, El Paso, Tex. There are 1,162 tanks in the room shown herewith and each tank evaporates about 90 lb. of acidic water daily, much of which condenses on the windows and sash and creates a condition ordinary putty cannot overcome. This problem is reported solved by the use of this type of rubber putty.

GREATER VENTILATION, EFFICIENCY and ECONOMY Everywhere in the mine!

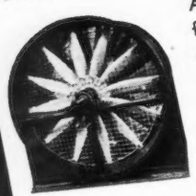
FOR PRESSURES up to 8"

Aerodyne mine fan—20,000 to 500,000 cu. ft. per minute—2½ to 900 H.P.—adjustable blades



FOR PRESSURES up to 4"

Aerodyne Junior fan—up to 10 ft. diameters—Easily dismantled for transporting through workings



FOR USE IN ANY SEAM

Type 61 blower with flexible tubing for ventilating dead ends

Aerodyne midget—125 lbs., height—17 inches, Flame-proof

BETTER VENTILATION AT LOWER COST

The above fans and blowers are typical of the complete line of Jeffrey ventilation equipment, which provides more air per dollar, better working conditions and greater production efficiency per worker. Topped by the Aerodyne (patented) which offers static efficiencies above 80% even for the smallest size, all Jeffrey fans reflect the same competent design in the savings they effect and better ventilation they offer. Write for complete details.

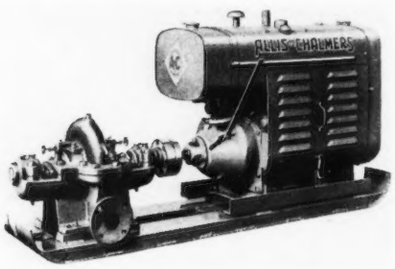
THE JEFFREY MANUFACTURING CO.

COLUMBUS OHIO, U. S. A.

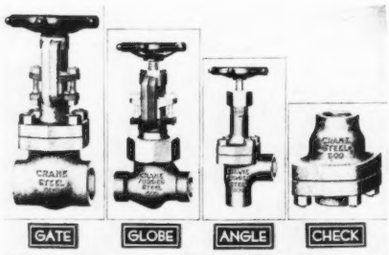
out joints and are supported by spool-type porcelain insulators. Inclosing screens protect the interior from falling material. Welding current can be adjusted over the welding range, in ten steps of approximately 17 amp. each, by means of five heavy knife switches. It is nominally rated at 250 volts, and will operate on a power line of 225 to 275 volts.

Engine-Driven Centrifugal Pumps

TO PROVIDE independently powered pumps for drainage, irrigation, gravel-washing plants, construction jobs, and similar applications, the Allis-Chalmers Manufacturing Company, Milwaukee,



Wis., announces a line of centrifugal pumps driven by gasoline power units in five sizes (18 to 110 hp.). Fuels such as gasoline, kerosene, distillate, natural gas, or butane may be used. The centrifugal pumps are horizontal shaft, single stage, single or double suction pumps designed for handling liquids at normal temperatures. The engines and pumps provide a capacity and pressure range up to 5000 g.p.m. and 100-ft. head.

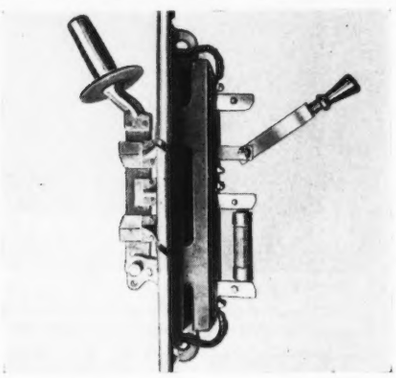


Crane Company, Chicago, Ill. announces a new line of small steel valves for steam and oil service. This new line includes gates, globes, and angle, and check valves in sizes ¼ in. to 2 in. inclusive.

Thew Shovel Company, Lorain, Ohio, announces the introduction of the "Moto-Crane"—a full revolving crane, convertible to shovel, dragline, clamshell, or backdigger—mounted on a 10-wheel, rubber-tired mounting. Five sizes are available, including heavy duty units to carry 100-ft. booms or longer.

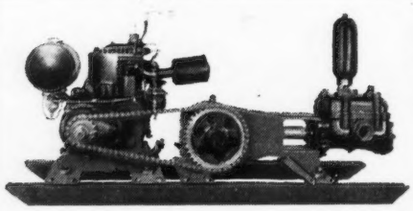
Auxiliary Switch for Mine Use

A NEW auxiliary section insulator switch, designed to minimize electrical fire hazards and to protect electrical equipment in mines, is announced by the Mosebach Electric & Supply Company, 1153 Arlington Ave., Pittsburgh, Pa. The new unit consists of a standard-



type Mesco insulator switch combined with a smaller switch which can be fused for any desired load.

Chief advantage of the new Mesco switch over ordinary switches is said to be that, although high amperage load can be routed through the larger switch during working periods, this switch can be opened and the smaller one closed during shutdown periods. The small switch passes sufficient ampere load to operate fans, small pumps, and other complementary apparatus, but if the amperage is suddenly increased the fuse burns out, stopping all current and protecting the equipment at the face.



PUMPING UNITS SPECIALLY DESIGNED for DIAMOND DRILLING

• Easily Accessible • Self Oiling • Light Weight • Sturdy

PRESSURE: to 300 lbs. per sq. inch; GALLONAGE: 400, 500, 750, 1200 per hour
POWERED WITH: 1, 2 or 4 H.P. Air Cooled Motor

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Diamond Drilling Contractors and Manufacturers

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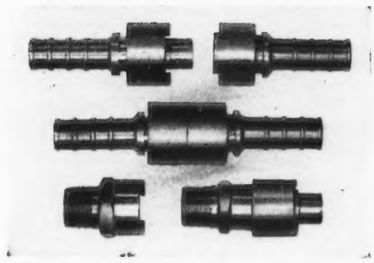
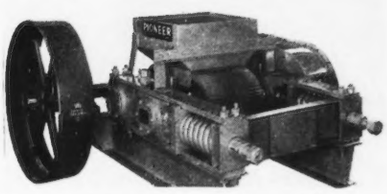
TORONTO, ONT. MANILA, P.I. KIRKLAND LAKE, ONT. MELBOURNE, AUSTRALIA PORT ARTHUR, ONT. SINGAPORE, S. S.



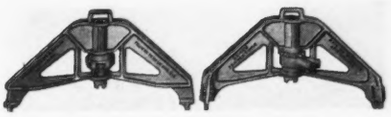
The Pittsburgh Brass Manufacturing Company, 3271 Penn Ave., Pittsburgh, Pa., has developed a new line of cast bronze hose couplings for joining similar or dissimilar sizes of rubber hose on air, water, steam, and gas lines operating up to 200-lbs. pressure per square inch. Standard sizes are available for ⅜, ½, on ¾ inch hose.



The Pioneer Engineering Works, Minneapolis, Minn., recently added a new roll crusher to their line. The new unit has rolls 16 in. in diameter, with a 16-in. face, and is equipped with fine corrugated rolls to produce small materials. Shells are manganese steel, and replaceable. The crusher is gear-driven, and all gears are located on one side of the crusher, and fully inclosed

New Tamping Material

CALCOT TAMPING for use in blasting operations is a recent offering of the California Cotton Mills Company, Oakland, Calif. The new material is said to be designed and manufactured specifically to meet underground conditions where blasting is done in drilled holes. Advantages claimed by the manufacturer are: (1) The spongy character of the material makes possible effective and rapid tamping, hence increased efficiency of powder and consequent lower powder costs; (2) will not freeze at low temperatures, dry out, or gather excessive moisture; (3) light weight and uniform construction, prerequisites for economic and convenient handling; and (4) chemical treatment has rendered it fireproof and non-clogging, thus eliminating fire hazards underground and clogging of underground pumping equipment. Each plug weighs about ⅓ oz., and cost compares favorably with that of conventional tamping mixtures prepared from clay, mill tailings, and others.



Gibraltar Equipment & Manufacturing Company, St. Louis, Mo., announces ratchet and standard type rail benders said to be light in weight and able to bend or straighten rails up to 120-lb.

BULLETINS

Wire Rope. A. Leschen & Sons Rope Co., St. Louis, offer a booklet entitled "Practical Information on the Use and Care of Wire Rope." Pp. 44.

Belt Lacing Products. Clipper Belt Lacer Co., Grand Rapids, Mich. The company offers four small folders entitled belt lacing products, Lubrihide pins, spindle tape lacing equipment, and condenser tape lacing equipment.

Ore Feeders. Morse Bros., 2900 Broadway, Denver, Colo. Bulletin 409 describes and illustrates the manufacturer's line of vari-stroke ore feeders. Pp. 4.

Ventilating Sets. DeBothezat Ventilating Equipment Division, East Moline, Ill. Bulletin File No. 30-D-1 illustrates and describes the manufacturer's line of axial-flow volume and pressure type fans. Pp. 24. **Bifurcators.** Units for removal of fumes, vapors, and high-temperature gases are also described and illustrated. Pp. 13.

Speed Reducers. D. O. Janes Mfg. Co., 1120 West Monroe St., Chicago, Ill. Catalog 17 describes and illustrates the manufacturer's speed reducers for industrial uses. Pp. 28.

Steel Tapes and Measuring Devices. Lufkin Rule Co., Saginaw, Mich. General Catalog 12A, 5¼x8 in., describes and illustrates the complete line of measuring devices sold by the company. Pp. 257.

Cars, Truck Bodies. Easton Car & Construction Co., Easton, Pa. Bulletin 210-A is a ring-binder type catalog describing and illustrating several types of mine and quarry cars, large-capacity trucks, and Granby-type cars for mining and other material handling uses. Trailers for heavy haulage duty are also described and illustrated. Pp. 47.

All-Purpose Lubricant. Valvoline Oil Co., 5th and Butler St., Cincinnati, Ohio. Folder describes the manufacturer's special lubricant for all purpose and all season use. Pp. 6.

Corrosion Resisting Steel. Bethlehem Steel Co., Bethlehem, Pa. Catalog 152 describes and illustrates the various industrial uses of the manufacturer's corrosion-resisting steel known as Mayari-R. Pp. 24.

Coming—In August

The 13th Annual

FEATURE ENTERPRISE NUMBER of E. & M. J.

Thousands of mining men will be interested in this ANNUAL edition, offering this year a comprehensive editorial treatment of successful mining and milling practices for the "Small" operator.

Many articles featuring design, layout, management, operating technique, mechanized loading, as successfully applied to small mines and mills, are being planned for this issue—a timely, useful service and a valuable reference record.

Advertising forms close July 29th at New York, N. Y.

For a SAFE, PROFITABLE INVESTMENT, choose

THE CONCENCO ANTI-FRICTION HEAD MOTION

With *SuperDuty* Deister-Overstrom Diagonal-Deck Tables, the Concenco Head Motion offers unusual efficiency and economy. Its smooth, quiet, mechanical action with more kick assures economical long-lived service and superior concentrating results.

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This NEW BULLETIN No. F8-B on the Denver Rotary Vacuum Filter is one you will want to have, so write for your copy today if you have not already received it. The all-metal construction, including cast filter segments, makes this unit outstanding. Acid resisting metals can be furnished. Check the advantages of Denver Filters. You will be surprised at the low price.

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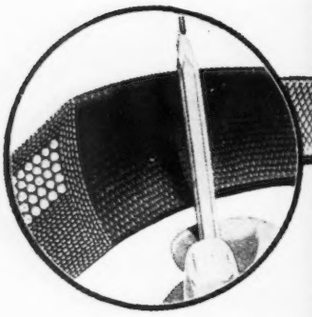
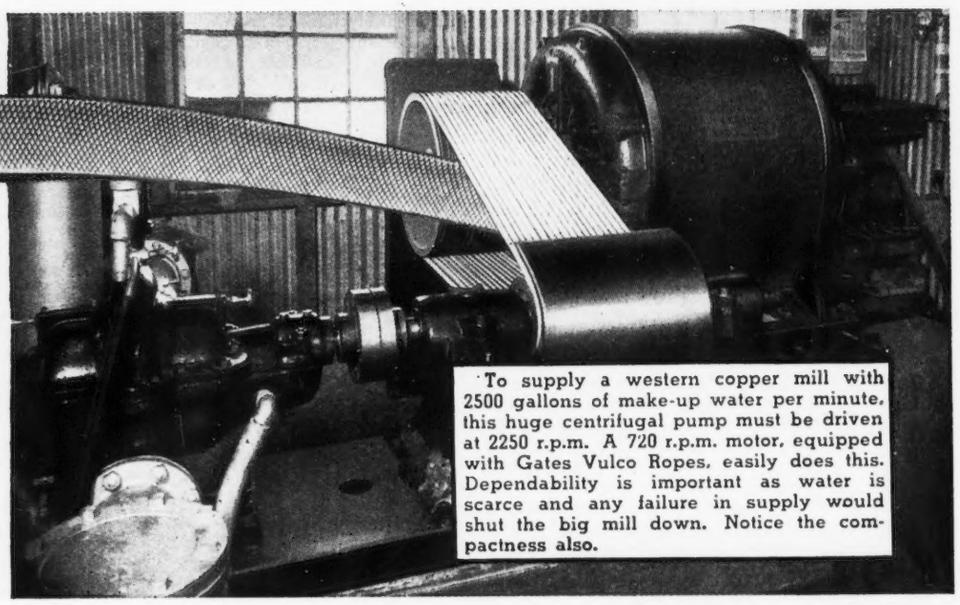
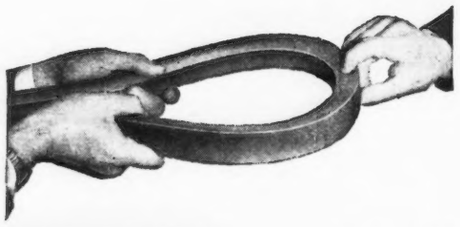


The **Concave Side**
IS A GATES PATENT



To supply a western copper mill with 2500 gallons of make-up water per minute, this huge centrifugal pump must be driven at 2250 r.p.m. A 720 r.p.m. motor, equipped with Gates Vulco Ropes, easily does this. Dependability is important as water is scarce and any failure in supply would shut the big mill down. Notice the compactness also.

Learn of a SUBSTANTIAL SAVING in BELTS and POWER by making This Simple Test



What Happens When a V-Belt Bends

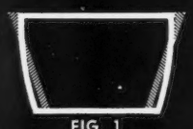


FIG. 1

FIG. 2

Grip with your fingers the sides of any V-Belt; then bend the belt and feel the sidewall change shape. Being under tension, the top of the belt narrows. The bottom, compressed, becomes wider. The sidewalls bulge. These stresses distort a straight-sided V-belt into a shape that does not fit the sheave groove—as shown in Figure 1 (on the left). Note the out-bulge of the sides.

Now bend a V-belt built with the patented concave side. You'll feel the same stresses, the same shape change with this big difference: the altered shape exactly fits the sheave groove—as shown in figure 2. Two advantages result. (1) No sidewall bulge; therefore uniform sidewall wear; longer life! (2) Full sidewall grip on the pulley; therefore less slippage on heavy loads or sudden load increases—a saving in belt wear and also in POWER.

The Gates Vulco Rope is the only V-Belt built with the patented concave side.

V-Belt in Sheave

It's the *sides* of a V-Belt that do all the *gripping* and get all the *wear*. That's why longer life for the *sides* means *longer life for the belt.*

THE GATES RUBBER COMPANY

Engineering Offices and Stocks in All Large Industrial Centers

GATES VULCO ROPE DRIVES

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DENVER, COLO., 999 South Broadway DALLAS, TEX., 2213 Griffin Street PORTLAND, ORE., 333 N. W. 5th Ave. SAN FRANCISCO, CAL., 2700 16th St.